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Lerista axillaris, a rare burrowing skink from Western Australia. See paper on page 6.
(Photo by G. Gaikhorst).

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HERPETOLOGICAL NOTES

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NOTES ON A MAXIMAL SIZED SCRUB PYTHON *MORELIA AMETHISTINA* (SERPENTES: PYTHONIDAE) FROM KURANDA, NORTH EAST QUEENSLAND

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Morelia amethistina is Australia's largest snake but accurate measurements of intact, maximal sized specimens are extremely rare (Greer, 1997). Uncorroborated claims of lengths in excess of 6 m are present in the literature (eg. Dean, 1954; Worrell, 1954). However, in a previous work, Fearn and Sambono (2000) provided a literature overview of large, field caught *M. amethistina* and suggested that there are no reliable, first hand accounts of scrub pythons exceeding 5.5 m in total length. The largest free ranging specimen accurately measured to date was a female, 5.651m in total length and weighing 24 kg (Fearn & Sambono, 2000).

Given the scarcity of accurate data for very large scrub pythons, the author provides the dimensions of a maximal sized male recently captured at Kuranda, north east Queensland.

The snake (Fig. 1) was discovered in a small corrogated iron pump house in a large rural/residential lawn where it appears to have sustained superficial damage to its head scales (Fig. 2) while gaining access to this structure. On November 30, 2001 data were collected from this snake and are presented in Table 1. Data collection procedures have been previously described in Fearn and Sambono (2000).

Figure 1. Large male Scrub Python from Kuranda

ACKNOWLEDGMENTS

Sincere thanks to Greg Watson for bringing this snake to my attention and assisting with data collection. Thanks also to Dane Trembath and David Freir for assistance with data collection.

Figure 2. Head of large male Scrub Python from Kuranda

Table 1. Measurements (mm) and mass (kg) of a maximal sized male *Morelia amethistina* from Kuranda, north east Queensland.

Snout to vent length (SVL)	**4730**
Tail (incomplete) length	**595**
Total length	**5325** (17 feet, 5 inches)
Head length (Along the lower jaw, from the tip of the snout to the posterior edge of the quadratearticular projection)	**113**
Head width (Between eyes)	**47**
(At base of skull)	**86**
Head depth (From top of head above eyes to underside of lower jaw)	**48**
Mass	**19**

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NOTES OF TERMITARIUM NESTING BY *VARANUS ROSENBERGI* IN WESTERN AUSTRALIA

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On 30th January 2001 I visited a small patch of bush just outside of Albany, WA. The area has a fairly high concentration of termite mounts of the genus *Nasutitermes*. One of these mounds was positioned on the side of a firebreak and I noticed a circular area half way up the mound, which was lighter in colour and indented slightly. Having read about the incubation techniques of several species of monitor I decided to investigate further. Excavating the circular entrance was very easy as the mound was soft and the lighter coloured area seemed freshly deposited. I dug down on a slight curve approximately 30 cm into the centre of the mound and found several leaves and woody material. While digging further I unfortunately damaged an egg approximately 4.5 cm long by 3 cm wide. The egg was in excellent condition and fertile with a very undeveloped embryo inside. At least two other undamaged eggs were still entombed, so I left them alone and repaired the nest. A diagram of the nest is shown in Figure 1.

The mound was 45 cm in height with the hole entrance 20 cm above ground level. The nest entrance had a diameter of 11 cm, which reduced in size to a diameter of 6 cm as the chamber became deeper. The hole curved into the centre of the mound and was about 30 cm deep. The nest hole was facing north-west with the mound in an opened area so it would receive full sun.

On leaving the mound I noticed an adult *V. rosenbergi* thermoregulating out the side of a piece of tin about 7 metres away. The animal was about 1 metre in total length and had poor body condition compared to other animals seen on the trip. This animal within half an hour had moved to within 1 metre of the mound and continued to bask at its base. Hence, I assumed it was the female that laid the eggs. The animal continued to bask as I left.

Ehmann *et al.* (1991) and King and Green (1999) reported similar observations on *V. rosenbergi*, with the female monitor regularly revisiting the mound for 2-5 weeks after egg laying.

It has been reported that the Australian varanids *V. giganteus*, *V. varius*, and the *V. gouldii* group (including *V. rosenbergi*) all use termite mounds as egg oviposition sites (Vincent & Wilson, 1999; King & Green, 1999). This record confirms that Western Australian *V. rosenbergi* utilise the same reproductive method.

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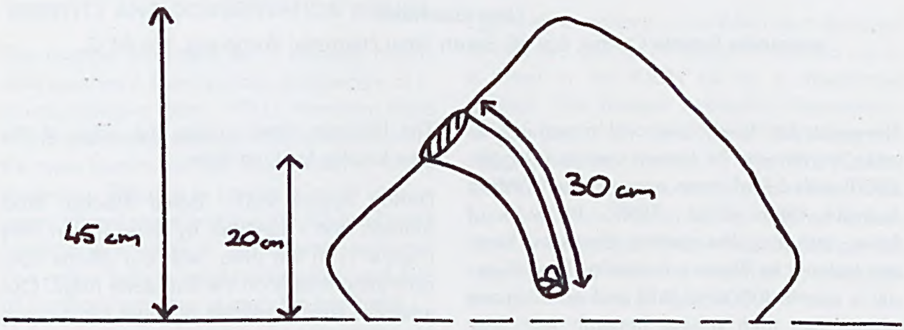
Figure 1. A diagram of the termite mound.



COMMENTS ON RANGE EXTENSION, CONSERVATION ISSUES AND THE IDENTITY OF *LERISTA AXILLARIS* (LACERTILIA: SCINCIDAE)

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The genus *Lerista* is the second largest in Australia, containing 74 known species (Cogger, 2000) with 57 of these occurring in Western Australia (Storr *et al.*, 1999). Forty six of these, including the species discussed here, are endemic to Western Australia. Their diversity is greatest in semi-arid and arid regions where they take refuge beneath leaf litter and/or topsoil as well as under rocks, logs and inside termite mounds (Cogger, 2000).

Lerista axillaris Storr, 1991 was originally described from a single specimen (Western Australian Museum R97212) collected 21 km south of Kalbarri (27°52'S 114°10'E) in 1987. It was diagnosed as a member of the *Lerista macropisthopus* group and most like the widespread species *L. macropisthopus*. However, it differed by possessing a dark upper lateral stripe, yellow venter, more elongate body, shorter limbs and a much longer and deeper forelimb groove (Storr, 1991; Storr *et al.*, 1999: Plate 1). The type locality consists of *Acacia rostellifera* scrub on brown sandy loam (Storr *et al.*, 1999) and is located in the northwestern extremity of the heavily cleared Western Australian wheatbelt.

Since 1987, a further four specimens (R116263, R129857, R146448-49) have been received by the Western Australian Museum from the type locality (L.A. Smith, pers. comm.).

In 1997, Arthur Ferguson, Brad Maryan and I visited the type locality, consisting of a remnant limestone ridge habitat with *Melaleuca* and *Acacia* woodland on brown sandy loam. This limestone ridge runs almost parallel to the Kalbarri-Northampton road on the eastern side, and is a prominent landscape feature extending from the type locality to approximately 35 km south of Kalbarri. The bitumen road crosses the ridge at the type locality for *L. axillaris*.

During August 2001, David Albaba, Brad Maryan and I sampled by hand fifteen sites (Figure 1) in the area, with our efforts concentrating mostly on the limestone ridge. Our intensive raking yielded a single *Lerista axillaris* (WAM R146448) from the western side of the Kalbarri-Northampton road opposite the type locality. Even though this only represented a short distance, it was nevertheless another locality record for the species. During our searches at several other sites along the limestone ridge, it became clear that these did not have the same soil type and vegetation structure as the type locality. There was also limited habitat left in the area, with most sites inspected being on agricultural land.

RANGE EXTENSION

In 1998, I searched a small area of bushland about 1 km north of Binnu, approximately 55 km east of the type locality (Figure 1). This remnant patch was only about 2 ha in size on a small hill and surrounded by cleared land. My attraction to this site was due to the amount of corrugated iron and other debris strewn around on the ground. After turning several pieces of iron, I found an adult *L. axillaris*, identified as this species by having two fingers, three toes, a dark upper lateral stripe and yellow belly (Figure 2). The habitat at this site is similar to the type locality and is slightly elevated on a small hill dominated by *Acacia* spp. The brown sandy loam here was intermixed with a granite component and consistent with other small hills in the vicinity that remained uncleared. This represents the only record of *L. axillaris* distant from the type locality. Despite further searching in the area, no further specimens have been found.

However, *L. macropisthopus galea* (with one finger and two toes) are relatively common.

IDENTITY AND CONSERVATION ISSUES

The original diagnosis for *L. axillaris* clearly distinguishes it from various subspecies of *L. macropisthopus* (Storr, 1991). However, three of the specimens subsequently collected from the type locality do not fully conform to the diagnosis, differing in having a much weaker upper lateral stripe and lacking the prominent forelimb groove (L.A. Smith, pers. comm.). The yellow belly is barely noticeable, and one of the three only has stumps for forelimbs.

At the Binnu site, there are also problems with the diagnostic differences between *L. axillaris* and *L. macropisthopus*. Alongside the *L. axillaris* I collected, several *L. macropisthopus galea* were also found with some indication of a lateral stripe and a yellowish belly, although all had a single finger and two toes, conforming to the diagnosis of this subspecies (Storr, 1991). It is also interesting to note that the westernmost record of *L. m. galea* cited by Storr (1991), WAM R33800 from 42 km ESE of Kalbarri, close to the type locality of *L. axillaris*, has two fingers as in *L. axillaris*.

In comparing the two taxa (Table 1), both are similar in extent of the forelimb groove, number of paravertebral scales (counted from first scale contacting parietals to last scale level with the vent), aspects of patterning, and body and limb proportions. The ratios of forelimb length, hindlimb length and forelimb to hindlimb distance to snout-vent length all show extensive overlap between the two taxa (forelimb length/snout-vent length: *L. axillaris* 0.035-0.053, mean = 0.042, n = 4; *L. m. galea* 0.033-0.050, mean = 0.040, n = 13; hindlimb length/snout-vent length: *L. axillaris* 0.094-0.149, mean = 0.127, n = 5; *L. m. galea* 0.116-0.194, mean = 0.150, n = 13; forelimb-to-hindlimb length/snout-vent length: *L. axillaris* 0.66-0.86, mean = 0.75, n = 5; *L. m. galea* 0.71-0.79, mean = 0.74, n = 13). This contradicts Storr's (1991) statement that *L. axillaris* has a more elongate body than *L. m. galea*.

They do differ by the number of digits (2/3 vs. 1/2) although there is some variation within this.

Currently *L. axillaris* is not listed as a declared threatened species in Western Australia nor is it listed in the IUCN list as a threatened animal. The Western Australian Department of Conservation and Land Management (CALM) lists this species as Priority 2 (CALM, 2000). These are taxa known from only a few animals within habitat not considered threatened or degraded. Before any species can be upgraded, surveys are required to evaluate status in the wild (CALM, 2000).

The limited information acquired so far, including the record from Binnu, is insufficient to alter CALM's assessment of the conservation status of *L. axillaris*. However, several points of interest can be raised regarding this species.

The species is known from very few specimens and like most *Lerista* spp. we know little about its ecology and biology. At the type locality it appears scarce based on capture rates in comparison to the similarly-sized *Lerista lineopunctulata*. If numbers of *L. axillaris* are low then genetic diversity may be at risk.

The two known collection sites are within areas heavily used for agriculture. The ecological impact of the loss of habitat is a corresponding reduction in available refuge sites, invertebrate food and increased fragmentation of what habitat remains. The elevated hills where it seems this species persists are quite rocky and possibly not suitable for crops. Similar habitat loss and impacts have been noted for the English Sand Lizard *Lacerta agilis*, where remaining isolated populations have been impacted upon by these activities (Dolman & Land, 1998). In Australia, the possibility of even a small fossorial reptile species being affected by habitat removal is clearly highlighted by the failure to locate further specimens of *Lerista allanae* in Queensland (Covacevich *et al.*, 1996).

The remaining hills in the area consist of isolated scrub patches scattered among the pad-

docks. To my knowledge, no studies have been done on activity ranges in *Lerista* spp. Considering the species' size, one could speculate that activity areas are fairly restricted within such reduced habitats, increasing the possibility of genetic isolation. The very restricted range for this species possibly exposes it more to other general threats such as erosion, introduced predators and fire.

CONCLUSION

Lerista axillaris is one of seventeen species in need of research to establish its current status in the wild (CALM, 2000). Field surveys of the Kalbarri and Binnu areas are required to gather information on ecology, biology, habitat usage and population size. If criteria suggest the species is possibly threatened, the small areas that support this species on agricultural properties will require preservation. In addition, the variation seen in the few specimens collected to date, and the overlap in diagnostic characters with some individuals of *L. m. galea* suggest that the taxonomic status of this species is in need of review.

ACKNOWLEDGMENTS

I wish to thank Glenn Shea and Laurie Smith for going over the manuscript and pointing me in the right direction. Also Brad Maryan for his input to the paper and excellent knowledge of *Lerista*. Arthur Ferguson, Dave Algaba and Brad Maryan assisted in the field, and James McLaughlin and Greg Burford gave the final OK. Thanks all. The Department of Conservation and Land Management and the Western Australian Museum provided ongoing support.

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Figure 1. Map of Kalbarri area, showing the type locality (21km S of Kalbarri), range extension (1km N Binnu) and 15 other sites where no *Lerista axillaris* were found. Base map from Department of Lands and Surveys (1986).

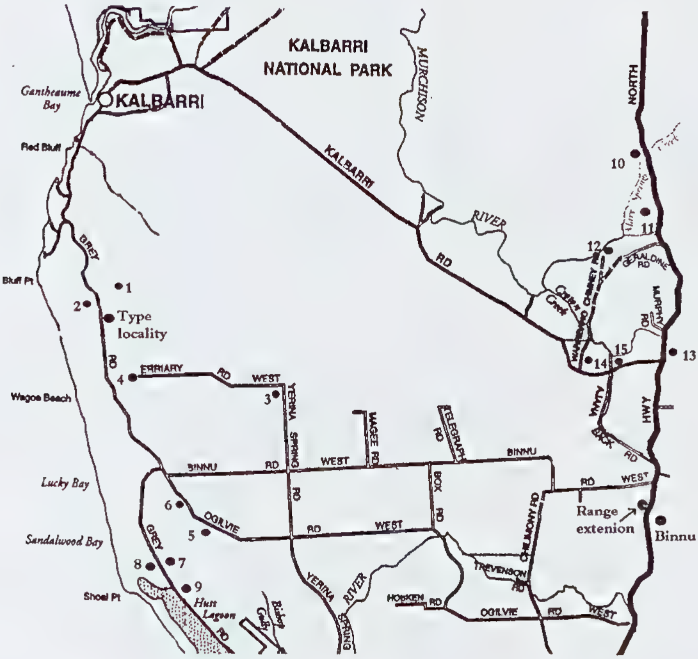

Figure 2. *Lerista axillaris* from 1km N Binnu.

Table 1. Data for *Lerista axillaris* records, and nearby records of *L. macropisthopus galea*.

Number	Locality	Paravertebral scales	Snout-vent length	Forelimb to hindlimb length	Forelimb length	Hindlimb length	Digits	Forelimb Groove	Description
Lerista axillaris									
R97212	21km S Kalbarri	88	87	75	3.0	8.2	2/3	Long and obvious (possibly due to desiccation)	Appears desiccated; eyes sunken.
R116263	21km S Kalbarri	83	62	45	stump, longer on right	8.5	0/3	Obvious on right, with longer stump	Smudging on posterior scales as lateral stripe
R129857	21km S Kalbarri	82	89	69	3.2	9.5	2/3	Not obvious	Dark brown smudging as lateral stripe
R146448	21km S Kalbarri	86	47	31	2.5	7	2/3	Not obvious	
R146449	21km S Kalbarri	84	67	48	3	10	2/3	Obvious groove for length of foreleg	1 scale wide dark lateral stripe; slightly yellow belly
Lerista macropisthopus galea									
R26505	45km NE Yuna	78	84	62	3.5	12.5	1/2	Obvious long groove	Plain in colour
R33800	42km ESE Kalbarri	83	70	50	3.5	12.5	2/2	Very small groove, barely noticeable	Plain in colour
R60484	122km N Mullewa MR crossing	84	82	62	3.0	13.4	1/2	Small but obvious groove	Plain in colour
R80726	10km NE Ajana	82	79	58	3.0	12.0	1/2	Small but obvious groove	Plain in colour
R116269	Ajana	82	87	65	3.5	10.1	1/2	Small but obvious groove	Plain in colour
R129771	Ajana	90	82	60	3.0	13.0	1/2	Small but obvious groove	Plain in colour
R129772	Ajana	88	81	60	3.5	11.5	1/2	Small but obvious groove	Plain in colour
R132452	Binnu	89	82	59	3.0	14.0	1/2	Obvious and long groove	Dark smudging–vertebral and lateral stripe
R135516	Binnu	88	90	71	3.0	11.5	1/2	Small but obvious groove	Dark smudging–vertebral and lateral stripe
R146392	Ajana	78	72	54	3.0	10.5	2/2	Small but obvious groove	Plain in colour
R146393	Ajana	92	80	60	3.0	11.0	1/2	Small but obvious groove	No claw on left digit
R146394	Ajana	78	67	52	3.0	13.0	1/2	Very small groove, barely obvious	Plain in colour
R146395	Binnu	83	86	62	3.0	10.0	1/2	Small but obvious groove	Plain in colour

PYGOPOD LIZARD PREDATION BY A WHITE-CROWNED SNAKE, *CACOPHIS HARRIETTAE*

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The genus *Cacophis* (Crowned Snakes) contains four described species, all of which are restricted to eastern Australia (Cogger, 2000). Crowned Snakes are nocturnal, prefer moist habitats, and prey predominately upon skinks (Shine, 1980; Wilson & Knowles, 1988). This note records a White-crowned Snake, *Cacophis harriettae*, feeding on a pygopodid.

On 21 May 2001 two adult White-crowned Snakes were unearthed while carrying out some bobcat work at the CSIRO's Pullenvale site, west of Brisbane. The site was located in an open grassed paddock, which had some large Grey Gums, *Corymbia citriodora*. There was very little ground cover as the area is slashed on a regular basis. There is a large area of native dry woodland adjacent to the site. The snakes appeared to be living in a small soil ridge that had been formed during previous earth works.

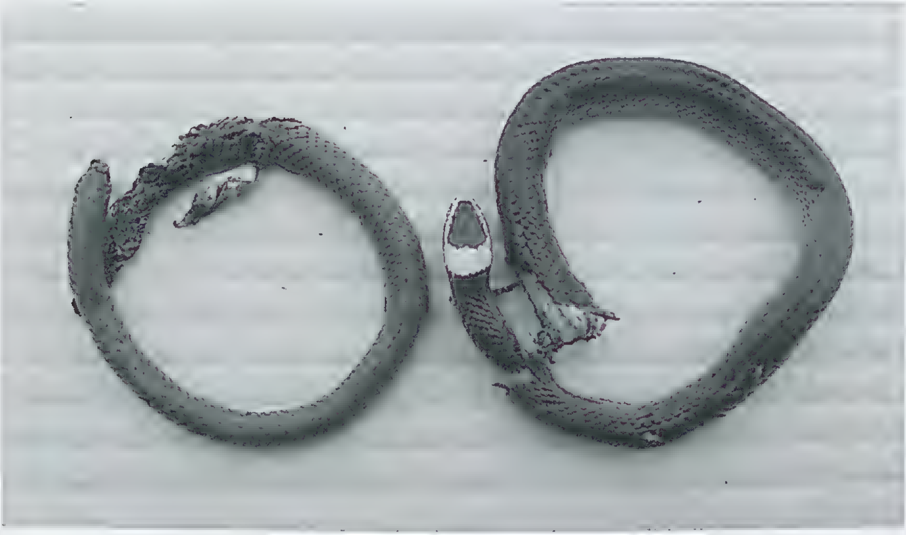
One snake was cut in half by the bobcat while the other was unharmed. The dead snake contained part of an adult *Delma plebeia*. There was no sign that the *Delma* had been digested so it is assumed that the snake had eaten the *Delma* within a day or two before being killed. The snake was cut mid body and was missing the tail section (Figure 1). About 160 mm of the *Delma* , consisting of lower body and upper tail, was removed from the snake's gut. The remains were identified as a pygopod by the presence of well developed hind flaps and as *Delma plebeia* by its size and colour which was consistent with local *Delma plebeia*, the only pygopod of that size and coloration occurring in the region.

Shine (1980) found that the diet of *Cacophis* species is almost exclusively skinks, which comprised 84% of the prey items in museum specimens. Prey items identified from the gut contents of *C. harriettae* belonged to the genera *Anomalopus, Ctenotus, Lampropholis, Leiolopisma* and *Sphenomorphus* (the latter two genera are not now regarded as occurring in the range of this species – presumably the *Sphenomorphus* are *Eulamprus* or *Glaphyromorphus* species, while the *Leiolopisma* are *Lampropholis, Saproscincus*, or *Cautula* species). Other items included skink eggs and unidentified skinks. Shine recorded one *C. squamulosus* containing *Lialis burtonis*, but the observation reported here appears to be the first record of *C. harriettae* preying on pygopodids.

All of the lizards recorded as dietary items for *C. harriettae* are known to be or thought to be diurnally active, which seems unusual for a cryptozoic snake, raising the possibility that the skinks were captured while at rest (Shine, 1980). This is supported by the present observation as it seems unlikely that the *C. harriettae* captured the normally diurnal and fast moving *Delma plebeia* while the latter was active.

The observation also supports the suggestion by Shine (1980) that *Cacophis* feed all year round. The weather just prior to the snakes being found was cool and overcast with occasional light showers. The temperature range for the days prior to the sighting was 10 - 22°C, while the total rainfall for the previous two days was 12.5 mm. While these conditions are still quite mild, other local species such as the Common Tree Snake *Dendrelaphis punctulatus* and the Freshwater Snake *Tropidonophis mairii* are not active and are rarely encountered at this time of year, although the Small-eyed Snake *Rhinoplocephalus nigrescens*, which is very common in Brisbane and has a similar

Figure 1. White-crowned Snake with gut contents removed.



cryptic behavior to *C. harriettae*, is commonly encountered throughout the year. The finding of this White-crowned Snake with food just prior to winter therefore supports the view that this species is active and feeds during the cooler parts of the year.

ACKNOWLEDGMENTS

I thank Ian Deszecsar for reporting the snakes.

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FROGS AND REPTILES OF GOOBANG AND NANGAR NATIONAL PARKS, CENTRAL WESTERN NSW.

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INTRODUCTION

Goobang and Nangar National Parks are on the central western slopes of New South Wales, east of the towns of Forbes and Parkes. They occupy the upper and mid-slopes of several small ranges, principally the Hervey Ranges, and drain into the Murray Darling Basin. They represent the western edge of the Great Dividing Range (Fig. 1) but are also closely associated with the western plains they overlook.

The parks are generally covered with forest and woodlands although there are now limited and localised areas of open grassland resulting from past clearing. There are also some rock outcrops and areas of naturally occurring heath, particularly along the ridgetops and upper slopes.

The parks are gradually becoming isolated from other large areas of natural vegetation, particularly to the west where clearing of the ironbark and box woodlands has been extensive. Only 16% of the native woody vegetation cover remains on the plains between Forbes and Lake Cargelligo (Sivertsen & Metcalfe, 1995).

Vegetation surveys identified six main vegetation communities in Nangar National Park (Anon, 1996) and nine in Goobang National Park (Porteners, 1997). Porteners (1997) found Goobang National Park to be the eastern or western limit for many plant species. As the parks are towards the western edge of the Dividing Range, a mixture of species characteristic of both the Great Dividing Range and of western NSW would be expected to occur in these areas.

The central western slopes of NSW appear to have a paucity of reptile records as is evident from perusal of the distribution maps shown in Swan (1990). To our knowledge no other fauna surveys have been undertaken in Goobang or Nangar National Parks. There are however, a number of important records collected by visitors to the parks or by NSW National Parks and Wildlife Service employees.

Fauna surveys were undertaken in these two parks to assist in the preparation of management and fire plans for the parks, and to increase our knowledge of the distribution of the fauna of the central-west. Results relating to herpetofauna are presented here.

METHODS

Vegetation survey sites (Anon, 1996; Porteners, 1997) were used to select 43 fauna survey sites in Goobang and 14 in Nangar. This subset of the original flora sites represented all vegetation communities present and the number of replicates were roughly in proportion to the area of each vegetation community.

At approximately half of the sites (where deeper soil was present) four pit traps were installed. These were 500 mm deep, 150 mm diameter white PVC pipes with metal bottoms. Five metre long drift fences ran out from either side of each trap. The pits were placed at corners of an approximate square about 20-30 m apart. The precise placement of pit-traps was dictated by soil conditions and localised topography. Pit traps were open for three days and nights.

At each site, a 30 minute search during the day (generally mid-morning) and another at night were completed. During these searches calling animals were identified, rocks and logs were turned and crevices and hollows

checked, burrows were excavated and leaf litter raked in an attempt to find reptiles and amphibians. When time permitted some additional areas away from the trapping sites were checked.

Animals were also recorded when encountered on roads or during other survey activities. Elliott traps (25 traps for three nights at each site) and hair tubes (four per site for the duration of each survey), primarily used to survey for mammals, also caught some reptiles.

Animals were identified and released at the point of capture either when checking traps or the following day. A number of captures that represented range extensions or problematic identifications were retained and lodged with the Australian Museum.

The NPWS Atlas of NSW Wildlife and unpublished reports (NPA, 1994; Goldney, 1990) provided a number of records of frogs and reptiles for the area.

RESULTS

Surveys were conducted between January and April 1997 and in January 1998. Dates and weather conditions during the trips are provided in Table 1.

A total of 13 amphibian species and 30 reptile species were recorded in the parks during the survey periods. A further 9 species were found outside the parks or were recorded previously. Appendices 1 and 2 list the amphibians and reptiles recorded in Nangar and Goobang National Parks and the surrounding areas.

A number of species considered to be outside their known range or marginal to their core populations were found. These included *Oedura monilis* (Ocellated Velvet Gecko), *Ctenotus allotropis*, *Ctenotus taeniolatus* (Copper-tailed Skink), *Egernia whitii* (White's Skink) and *Lampropholis delicata* (Garden Skink).

Table 2 shows the vegetation types used by frogs and reptiles recorded at the 57 sites (10 frogs and 26 reptiles). Vegetation types shown are a combination of those given in Anon (1996), Porteners (1997) and our own interpretation.

DISCUSSION

Several limited rain periods generated some frog activity but more species would be found during wet, warm weather. Low capture rates of reptiles and frogs were recorded in the cool of early autumn in Nangar National Park. Additional sampling in warmer months may provide additional records for this park.

White box/riparian and stringybark woodlands had the highest species richness of all the vegetation communities (Fig. 2). However, a high number of species was found in the semi-arid white cypress and bulloak woodlands, even though only five sites were surveyed in this community. Four species of reptile, *Ctenotus allotropis, Lerista muelleri, Oedura monilis* and *Vermicella annulata*, were only found in this vegetation type within Goobang National Park.

The semi-arid woodlands make up only a small area of Goobang National Park and are at their eastern geographic limit, however they make a significant contribution to the park's diversity. Due to clearing west of the park (Sivertsen & Metcalfe, 1995) little of the semi-arid woodlands remain in the region. The remnants within the park are important for the conservation of the associated species.

Threatened species

No threatened reptiles or frogs were found in or near the parks but the Southern Bell Frog (*Litoria raniformis*) and the Pink-tailed Worm-lizard (*Aprasia parapulchella*) are predicted to occur based on climatic requirements (Ayers *et al.*, 1996).

It is unlikely that the Southern Bell Frog (*Litoria raniformis*) occurs in the parks. There are no creeks with permanently flowing water, no substantial pools, no river channels and only a small number of artificial dams. There

are also no records from nearby on the Macquarie, Bogan or Lachlan Rivers.

The Pink-tailed Worm-lizard (*Aprasia parapulchella*) is known to occur in grassland and around rock outcrops and there is a scattering of suitable habitat in both parks. Prolonged targeted searching will be required to detect this species in the parks.

Species of conservation concern

Some of the species found in Goobang National Park are of regional conservation significance or have populations in decline in western New South Wales (Sadlier *et al.*, 1996). These include Ocellated Velvet Gecko (*Oedura monilis*), Tiger Snake (*Notechis scutatus*), Red-bellied Black Snake (*Pseudechis porphyriacus*), and Carpet Python (*Morelia spilota variegata*).

Ocellated Velvet Gecko (*Oedura monilis*)

Sadlier *et al.* (1996) state that the Ocellated Velvet Gecko has a moderately restricted distribution both nationally and statewide. The losses of woodland habitat and trees with crevices and hollows are potentially threatening this species. Two Ocellated Velvet Geckos were found in the semi-arid white cypress and bulloak woodland habitat on the western side of Goobang National Park.

Tiger Snake (*Notechis scutatus*)

Populations of the Tiger Snake on the Murray/Darling appear to be in decline (Sadlier *et al.*, 1996). Worrell (1958) wrote that 300 Tiger Snakes were collected in the Forbes-Condobolin area in ten days and that 300 were shot by farmers on a weekend following the 1951 Lachlan floods. He also writes (p. 105) "In some, almost inaccessible, parts of the (Lachlan) river we found Tiger Snakes in large numbers, but anywhere in reach of a township was hardly worth the search." Following the 1952 winter floods on the Lachlan many Tiger Snakes were again seen but apparently (p. 106) '... icy flood waters killed hundreds of snakes. Almost every low hollow held the body of at least one tiger that had stiffened with the cold and drowned."

While not recorded during the survey the Tiger Snake is known from around Goobang National Park (NPA, 1994) and should be expected to occur in areas such as "dry sclerophyll forest, grasslands, swampy and moist areas" (Swan, 1990). Given there has been such a dramatic reduction in the abundance of Tiger Snakes in the central-west, and that there are now only scattered records from here and further west, this species is of local conservation concern.

Red-bellied Black Snake (*Pseudechis porphyriacus*)

The Red-bellied Black Snake appears to be in decline on the Murray/Darling drainage (Sadlier *et al.*, 1996). There are only scattered records from the central western slopes and further west and as such this species is of local conservation concern. Nine Red-bellied Black Snakes were seen in and around Goobang National Park near creeklines, swampy areas and farm dams. This species should also occur in Nangar National Park.

Carpet Python (*Morelia spilota variegata*)

Shine (1994) asserts, based on anecdotal evidence, that the Carpet Python has 'declined considerably' in western NSW. A number of landholders near Goobang and Nangar National Parks recalled seeing Carpet Pythons in the area, including one at Ginghams Gap in Goobang, but most do not recall any sightings in about the last 10 years. The species is still in the area, having been seen in the southern section of Goobang National Park during rabbit control works (Peter Myler, pers. comm., 1997). Another is known to have been recently relocated to the Bumberry section of Goobang National Park from the town of Parkes. The parks contain habitats considered suitable for these pythons including riparian habitats with hollow bearing trees, north and west facing cliffs and access to rural areas with high densities of rodents and rabbits. However, most of the landscape around the parks is modified and there are large numbers of foxes present on

the margins of both parks. Long term persistence of this species will depend on predator numbers and the availability of shelter.

Biogeography

Records of frogs and reptiles held by the Australian Museum and the NPWS Atlas of NSW Wildlife, Swan (1990) and Longmore (1989) were used to determine which species were near the edge of, or beyond their known range in the study areas.

Some coastal or coastal range species are found further west than Goobang and Nangar but only on the Victorian coast, in the southern highlands of NSW (which are slightly further west than Goobang/Nangar although slightly closer to the coast) or, in some cases, along inland waterways. In such cases the species are included here since the area to the west of the parks is unsuitable for them.

Some western species included here are found further east but only in northern NSW and southern Queensland where the coastline, and the coastal ranges, are further east than at the latitude of the parks.

Species at the western limit of their range

Eastern Froglet (*Crinia signifera*)

There are only scattered records for this species to the west of the parks. They were found in farm dams outside the park and in various woodland types within the park. There is much suitable habitat for this species to the west and it is likely that the species extends somewhat further. However surveys of that area are required.

Jacky Dragon (*Amphibolurus muricatus*)

Jacky Dragons have been recorded north-west of Goobang National Park, at the Macquarie Marshes (Australian Museum) and from south-west of Nangar National Park, at Reefton State Forest (Atlas of NSW Wildlife). In Goobang this species was found in grassy box woodland. It is likely that suitable habitat to the west of Goobang National Park is very limited.

Eastern Tiger Snake (*Notechis scutatus*)

There are only scattered records for this species west of the parks (Longmore, 1989). Regional declines in this species are discussed above.

Southern Rainbow Skink (*Carlia tetradactyla*)

This species was found in ironbark and stringybark woodland but was also found in cleared areas around houses adjacent to the park. Since this species has survived in disturbed sites adjacent to the park it may occur further west in remnant pockets of woodland or in grassed areas associated with homesteads. At present however, the records in Goobang and Nangar National Parks are the westernmost.

Copper-tailed Skink (*Ctenotus taeniolatus*)

Ctenotus taeniolatus was found in almost all vegetation types except the semi-arid woodlands in western Goobang. They may be expected to occur in some isolated pockets further west.

Cunningham's Skink (*Egernia cunninghami*)

One *Egernia cunninghami* was found in Nangar National Park on basalt outcrops on a creekline. In the central-west this is the western-most record. Further west suitable rocky country becomes extremely scarce, limiting the potential occurrence of this species.

White's Skink (*Egernia whitii*)

Found in both Goobang and Nangar National Parks, these are the westernmost localities for central-western NSW. This species was found in open heathland, ironbark and stringybark communities usually on hill tops near rocky outcrops (such as Mt Nangar in Nangar National Park and Caloma Trig. Station in Goobang National Park). The lack of significant ranges with suitable climatic conditions probably prevents this species from occurring much further west, although several smaller ridge systems

may have isolated populations.

Garden Skink (*Lampropholis delicata*)

Other than an unconfirmed record of this species from the Macquarie Marshes (Atlas of NSW Wildlife) this is the westernmost record for this species. Occurring in grassy woodlands (box and stringybark) in Goobang National Park, this species may be restricted by a lack of suitable habitat and climatic conditions further west.

Bougainville's Skink (*Lerista bougainvillii*)

This species was recorded from Nangar National Park in 1993. There is a record of this species from Weddin Mountains National Park (Atlas of NSW Wildlife), but it is unlikely that suitable habitat occurs west and north of Goobang National Park.

Species at the eastern limits of their range

Desert Tree Frog (*Litoria rubella*)

This species was found in riparian and stringybark communities in Goobang. To the east there are only a few scattered records. There are most likely reasonable populations to the east but reliable information on the distribution of frogs in the central-west of the state is limited.

Sloane's Frog (*Crinia sloanei*)

This species typically inhabits the western plains of NSW (Cogger, 1994) but was captured on the western slopes of Goobang National Park in box woodlands. With the clearing of forests to the east of the parks creating woodland and disturbed habitats, additional areas may be becoming suitable for this species based on the habitat description of Robinson (1995).

Crucifix Toad (*Notaden bennettii*)

There are two records of this species immediately west of Goobang National Park (Atlas of NSW Wildlife; Dan Smillie, pers. comm.). While not recorded within the parks they may occur in the semi-arid woodlands on the western side of Goobang National Park and perhaps in the grasslands of Nangar National Park.

Eastern Spiny-tailed Gecko (*Diplodactylus intermedius*)

This species was recorded from ironbark and black cypress woodland and from the semi-arid white cypress and bulloak woodland. There are no records of this species further east in central-western NSW.

Tree Dtella (*Gehyra variegata*)

The Tree Dtella was recorded from a variety of habitats and it probably occurs in all of the vegetation associations represented in the parks. There are two records for this species less than 20 km to the east of the Goobang (Australian Museum). Further searching would probably reveal more populations, but it has not been reported from towns to the east such as Orange and Wellington.

Carnaby's Wall Skink (*Cryptoblepharus carnabyi*)

There are three museum records from south-east of Nangar National Park and it is likely that this species will be found at least through to the Dubbo/Wellington/Orange road (Mitchell Highway). However, at present there are no records to the east of the parks. In the parks, this species was found in riparian, stringybark and semi-arid communities.

Ctenotus allotropis

One specimen was captured in the semi-arid white cypress and bulloak woodland on the western side of Goobang National Park. It is most likely restricted to this area of the park. In the central-west this is the easternmost record and it is unlikely that this species will be found further east.

Mueller's Skink (*Lerista muelleri*)

This species was found in the semi-arid vegetation on the western side of Goobang National Park. This species could extend into the grassland to the east of Goobang

although there are presently no known records.

Species at the southern limits of their range

Northern Banjo Frog (*Limnodynastes terraereginae*)

There are two Atlas of NSW Wildlife records for this species south of Nangar National Park, both on the south coast of NSW. One of these is noted to be considered a "suspect record" and the reliability of the other may be questioned. *Limnodynastes terraereginae* was found in riparian and stringybark communities in Goobang National Park. With searches in appropriate weather it may potentially be found in Nangar National Park.

Broad-palmed Frog (*Litoria latopalmata*)

A number of individuals were captured along creeklines and in dams in Nangar National Park. This species extends further south on the coast and subsequent to the Goobang and Nangar surveys, records of this species have been made along the floodplain of the Murrumbidgee River near Wagga Wagga as well as at Cowra on the Lachlan River. It is likely that the species occurs in the intervening area but further survey work, particularly along river systems, is required to verify this.

Ocellated Velvet Gecko (*Oedura monilis*)

Two specimens of this species were captured in the semi-arid white cypress and bulloak woodland on the western side of Goobang National Park. This is the southernmost record of this species, the previous limit being the Dubbo area (Swan, 1990). For further comments see Species of Conservation Concern.

Spotted Black Snake (*Pseudechis guttatus*)

This species is regularly recorded from the NSW north-west slopes and plains. Two individuals were found dead on roads bordering the parks and can also be expected within the parks.

Miscellaneous observations

A road-killed Spotted Black Snake (*Pseudechis guttatus*) from near Tomingley at the north end of Goobang and an Eastern Brown Snake (*Pseudonaja textilis*) from the Eugowra/Orange road were dissected. A House Mouse (*Mus musculus*) was found in the stomach of each.

On a property to the east of Goobang National Park, near 'The Trig', in open grassland a Brown Falcon (*Falco berigora*) was seen swooping on and darting away from an Eastern Brown Snake (*Pseudonaja textilis*), apparently in an attempt to capture it. The bird was frightened away when the snake was approached and captured for identification.

CONCLUSIONS

Consistent with the location of the two parks at the peripheries of the NSW central western slopes and the western plains, the parks contain a mixture of species of different biogeographic derivations in proportions that approximate the mosaic of habitat types represented. As such they represent a valuable contribution to herpetofauna conservation, particularly with the degree of clearing of native vegetation in central-west NSW.

The parks have some vegetation links with the eastern ranges along the uncleared ridge lines. However, they are becoming increasingly isolated from native vegetation to the west with continued clearing of the plains. Special care is needed to prevent the loss of the western species from the parks. With limited linkages to the west, there is little chance of recolonisation for some Eyrean woodland species if they become locally extinct. Species such as *Lerista muelleri*, that can utilise cleared areas, are not under such threat and should be able to recolonise the parks from surrounding grazing lands should the parks' populations disappear.

The potential exists for the vegetation refuges and corridors that the parks represent to be enhanced by revegetation work associated with regional vegetation planning processes,

in particular the Mid-Lachland Regional Vegetation Management Plan being administered by the Department of Land and Water Conservation. If carried out effectively this could improve the viability of populations of many species both on and off the parks. For many areas this will require considerable replanting of perennial vegetation and should consider the value of that habitat for wildlife. Similarly, planning for water conservation, use and stream bank maintenance may improve riparian herpetofauna habitats. The plains immediately west of the parks are prime candidates for regional vegetation planning and the potential for planning corridors across the landscape and re-establishing blocks of native vegetation now exists.

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APPENDIX 1

Reptiles and Amphibians of Nangar National Park

* indicates that species was only found outside the park.

Class Amphibia
Order Salientia
Family Hylidae
Litoria latopalmata (Broad-palmed Frog)
Litoria peronii (Peron's Tree Frog)

Family Myobatrachidae
Limnodynastes dumerilii (Eastern Banjo Frog)
Limnodynastes tasmaniensis (Spotted Grass Frog)
Crinia parinsignifera (Plains Froglet)
Crinia signifera (Common Eastern Froglet)

Class Reptilia
Order Squamata
Family Agamidae
Amphibolurus nobbi (Nobbi)
Pogona barbata (Bearded Dragon)

Family Elapidae
Pseudechis guttatus (Spotted Black Snake) *
Pseudonaja textilis (Eastern Brown Snake)

Family Gekkonidae
Diplodactylus intermedius (Eastern Spiny-tailed Gecko) (Atlas of NSW Wildlife)
Diplodactylus vittatus (Wood Gecko)
Gehyra variegata (Tree Dtella)
Underwoodisaurus milii (Thick-tailed Gecko)

Family Scincidae
Carlia tetradactyla (Southern Rainbow Skink) *
Cryptoblepharus carnabyi (Carnaby's Wall Skink)
Ctenotus robustus (Striped Skink)
Ctenotus taeniolatus (Copper-tailed Skink)
Egernia cunninghami (Cunningham's Skink)
Egernia striolata (Tree Skink)
Egernia whitii (White's Skink)
Lerista bougainvillii (Bougainville's Skink) (Atlas of NSW Wildlife)
Morethia boulengeri (Boulenger's Skink)
Trachydosaurus rugosus (Shingle-back) *

Order Testudines
Family Chelidae
Chelodina longicollis (Eastern Long-necked Tortoise)

APPENDIX 2
Reptiles and Amphibians of the Goobang National Park Area

* indicates that species was only found outside the park.

Class Amphibia
Order Salientia
Family Hylidae
Litoria caerulea (Green Tree Frog)
Litoria latopalmata (Broad-palmed Frog)
Litoria peronii (Peron's Tree Frog)
Litoria rubella (Desert Tree Frog)

Family Myobatrachidae
Crinia parinsignifera (Plains Froglet)
Crinia signifera (Common Eastern Froglet)
Crinia sloanei (Sloane's Froglet)
Limnodynastes dumerilii (Eastern Banjo Frog) (NPWS Atlas of NSW Wildlife)
Limnodynastes interioris (Giant Banjo Frog)
Limnodynastes ornatus (Ornate Burrowing Frog)
Limnodynastes tasmaniensis (Spotted Grass Frog)
Limnodynastes terraereginae (Northern Banjo Frog)
Neobatrachus sudelli (Common Spade-foot Toad)
Notaden bennettii (Crucifix Toad) (NPA, 1994) *
Uperoleia sp. (a toadlet) *

Class Reptilia
Order Squamata
Family Agamidae
Amphibolurus muricatus (Jacky Dragon)
Amphibolurus nobbi (Nobbi)
Pogona barbata (Bearded Dragon)

Family Boidae
Morelia spilota variegata (Carpet Python) (NPA, 1994)

Family Elapidae
Demansia psammophis (Yellow-faced Whip Snake)
Pseudechis guttatus (Spotted Black Snake) *
Pseudechis porphyriacus (Red-bellied Black Snake)
Pseudonaja textilis (Eastern Brown Snake)
Suta spectabilis
Notechis scutatus (Eastern Tiger Snake) (NPA, 1994)
Vermicella annulata (Bandy Bandy)

Family Gekkonidae
Diplodactylus intermedius (Eastern Spiny-tailed Gecko)
Diplodactylus vittatus (Wood Gecko)
Gehyra variegata (Tree Dtella)
Oedura monilis (Ocellated Velvet Gecko)
Underwoodisaurus milii (Thick-tailed Gecko)

Family Pygopodidae
Delma inornata (Olive Legless Lizard)
Lialis burtonis (Burton's Snake-lizard)

Family Scincidae
Carlia tetradactyla (Southern Rainbow Skink)
Cryptoblepharus carnabyi (Carnaby's Wall Skink)
Ctenotus allotropis
Ctenotus robustus (Striped Skink)
Ctenotus taeniolatus (Copper-tailed Skink)
Egernia striolata (Tree Skink)
Egernia whitii (White's Skink)
Lampropholis delicata (Grass Skink)
Lerista muelleri
Morethia boulengeri (Boulenger's Skink)
Tiliqua scincoides (Eastern Blue-tongued Lizard)
Trachydosaurus rugosus (Shingle-back)

Family Varanidae
Varanus gouldii (Gould's Goanna)
Varanus varius (Lace Monitor)

Order Testudines
Family Chelidae
Chelodina longicollis (Eastern Long-necked Tortoise)

Figure 1. The location of Goobang (northern area) and Nangar (southern area) National Parks. Shading indicates an altitude of more than 500 m.

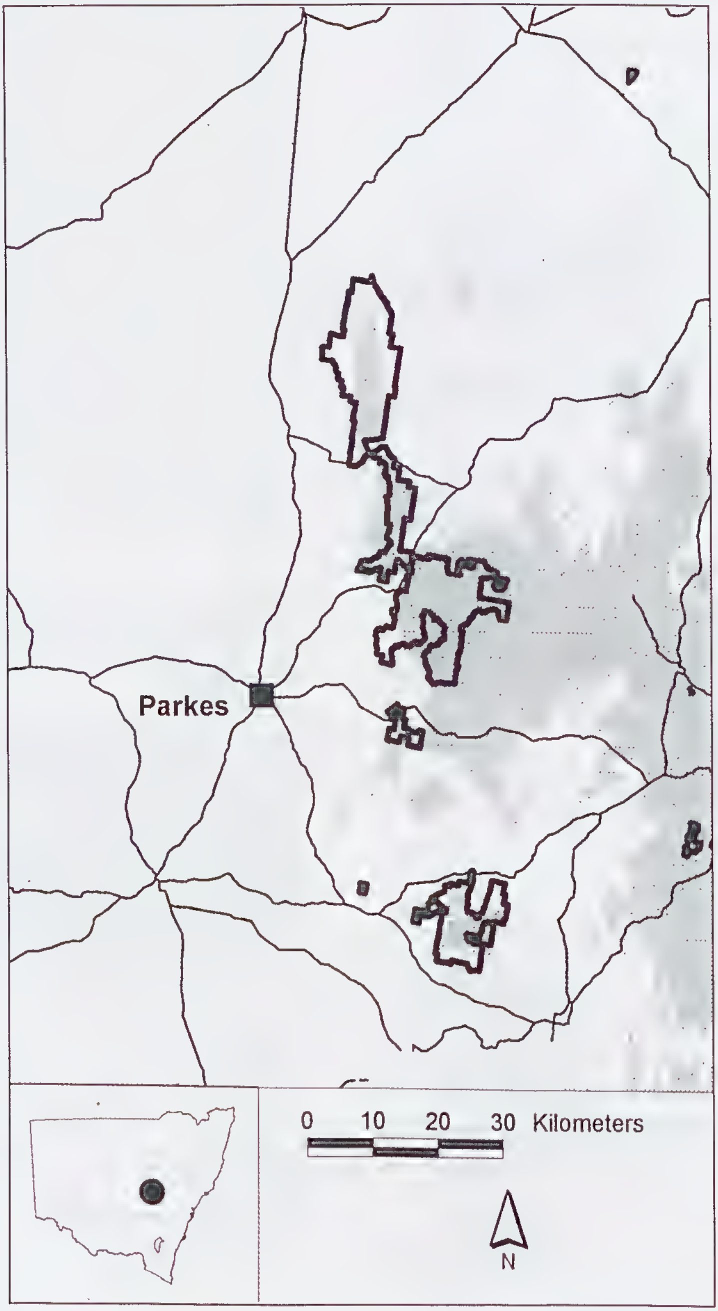

Figure 2. Species richness of broad vegetation categories (after Porteners, 1997) in Goobang and Nangar National Parks.

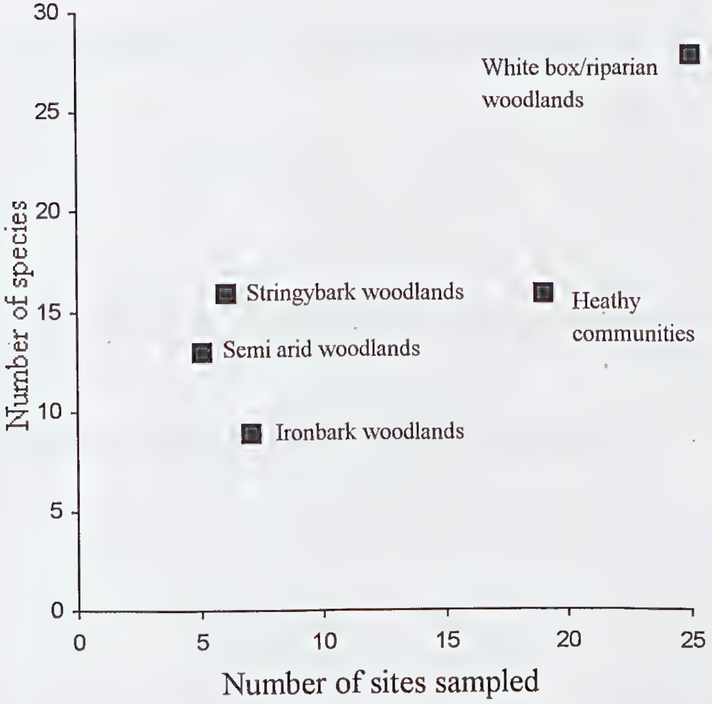

Table 1. Dates of surveys, temperature ranges and rainfall for Goobang and Nangar National Parks surveys.

Dates	Location	Min temp range (°C)	Max temp range (°C)	Rain (mm)
28 Jan - 7 Feb 1997	Goobang north	13-19	23-37	5.2
24 Feb - 7 Mar 1997	Goobang south	12-19	24-38	9.0
24 Mar - 4 Apr 1997	Nangar	3-14	13-33	0
19 - 30 Jan 1998	Goobang additional	14-25	29-38.5	3.6

Table 2. Habitats of frogs and reptiles found on sites in Goobang and Nangar NPs. Vegetation categories are an adaptation of Porteners (1997) and Anon (1996).",

	Heathy Communities				White Box and Riparian Communities			Other Ironbark communities	Stringybark Communities			Semi arid community
	Open heathland	Tumbledown Red Gum Woodland	Inland Scribbly Gum Woodland	Ironbark, Red Stringybark Woodland	Mugga Ironbark and Black Cypress Pine Woodland	Red Gum, Yellow Box, Grey Box Woodland	White Box Woodland	Red Ironbark and Black Cypress Pine Woodland	Red Stringybark Woodland	Red Stringybark and Bundy Box Woodland	Red Stringybark and Inland Scribbly Gum Woodland	White Cypress Pine and Bulloak Woodland
Eastern Spiny-tailed Gecko *Diplodactylus intermedius*								✓				✓
Wood Gecko *Diplodactylus vittatus*		✓		✓	✓			✓		✓		✓
Tree Dtella *Gehyra variegata*		✓		✓		✓					✓	✓
Ocellated Velvet Gecko *Oedura monilis*												✓
Thick-tailed Gecko *Underwoodisaurus milii*				✓		✓					✓	
Burton's Snake-lizard *Lialis burtonis*		✓			✓							
Bearded Dragon *Pogona barbata*	✓					✓	✓		✓			
Jacky Lizard *Amphibolurus muricatus*	✓					✓				✓		
Nobbi *Amphibolurus nobbi*	✓	✓	✓	✓	✓				✓	✓		✓
Gould's Goanna *Varanus gouldii*					✓							✓
Lace Monitor *Varanus varius*					✓	✓						
Southern Rainbow Skink *Carlia tetradactyla*					✓				✓			✓
Carnaby's Wall Skink *Cryptoblepharus carnabyi*				✓	✓	✓						✓
Striped Skink *Ctenotus robustus*					✓	✓		✓	✓	✓		
Copper-tailed Skink *Ctenotus taeniolatus*	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
Ctenotus allotropis												✓
Tree Skink *Egernia striolata*		✓		✓	✓	✓	✓	✓	✓		✓	✓
White's Skink *Egernia whitii*				✓				✓				
Grass Skink *Lampropholis delicata*						✓				✓		
Lerista muelleri												✓

	Heathy Communities				White Box and Riparian Communities			Other Ironbark communities	Stringybark Communities			Semi arid community
	Open heathland	Tumbledown Red Gum Woodland	Inland Scribbly Gum Woodland	Ironbark, Red Stringybark Woodland	Mugga Ironbark and Black Cypress Pine Woodland	Red Gum, Yellow Box, Grey Box Woodland	White Box Woodland	Red Ironbark and Black Cypress Pine Woodland	Red Stringybark Woodland	Red Stringybark and Bundy Box Woodland	Red Stringybark and Inland Scribbly Gum Woodland	White Cypress Pine and Bulloak Woodland
Boulenger's Skink *Morethia boulengeri*		✓		✓		✓	✓	✓		✓	✓	✓
Shingle-back *Trachydosaurus rugosus*		✓			✓	✓		✓				
Yellow-faced Whip-snake *Demansia psammophis*				✓								
Suta spectabilis					✓							
Eastern Brown Snake *Pseudonaja textilis*			✓		✓							
Bandy-Bandy *Vermicella annulata*												✓
Giant Banjo Frog *Limnodynastes interioris*		✓										
Spotted Grass Frog *Limnodynastes tasmaniensis*					✓		✓					
Northern Banjo Frog *Limnodynastes terraereginae*					✓				✓			
Common Spadefoot Toad *Neobatrachus sudelli*								✓	✓			
Ornate Burrowing Frog *Limnodynastes ornatus*					✓		✓					
Common Eastern Froglet *Crinia signifera*						✓	✓					
Crinia sp.	✓					✓	✓					
Green Tree Frog *Litoria caerulea*					✓		✓		✓			
Peron's Tree Frog *Litoria peronii*							✓					
Desert Tree Frog *Litoria rubella*					✓		✓		✓			
Number of species	5	8	3	10	18	14	11	9	10	7	5	13
Number of sites sampled	2	5	3	9	7	11	7	7	2	2	2	5

The vegetation categories used in this table are composed of one or more described categories as outlined below:

Open heathland: 8. Open heathland (Porteners, 1997); **Tumbledown Red Gum Woodland**: 6. Tumbledown Red Gum Woodland (Anon, 1996), 1. Tumbledown Red Gum and Dwyer's Red Gum (Porteners, 1997); **Inland Scribbly Gum Woodland**: 2. Inland Scribbly Gum (Porteners, 1997); **Ironbark, Red Stringybark Woodland**: 5. Red Ironbark, Red Stringybark Woodland (Anon, 1996), 5. Red Ironbark and Red Stringybark (Porteners, 1997); **Mugga Ironbark and Black Cypress Pine Woodland**: 3a. Ironbark and Black Cypress Pine (Porteners, 1997); **Red Gum, Yellow Box, Grey Box Woodland**: 1. Grey Box Woodland, 3. Blakely's Red Gum, White Cypress Pine Woodland (Anon, 1996), 6. Red Gum, Yellow Box and Grey Box (Porteners, 1997); **White Box Woodland**: 2. White Box Woodland (Anon, 1996), 7. White Box (Porteners, 1997); **Red Ironbark and Black Cypress Pine Woodland**: 3b. Ironbark and Black Cypress Pine (Porteners, 1997); **Red Stringybark Woodland**: 4a. Red Stringybark (Porteners, 1997); **Red Stringybark and Bundy Box Woodland**: 4b. Red Stringybark (Porteners, 1997); **Red Stringybark and Inland Scribbly Gum Woodland**: 4. Red Stringybark, Inland Scribbly Gum Woodland (Anon, 1996); **Cypress Pine and Bulloak Woodland**: 9. White Cypress Pine and Bulloak (Porteners, 1997).

THE INTRODUCED SNAKE MITE *OPHIONYSSUS NATRICIS* ON WILD POPULATIONS OF EASTERN BLUE TONGUE LIZARDS (*TILIQUA SCINCOIDES*)

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INTRODUCTION

The snake mite *Ophionyssus natricis* is a tenacious and debilitating macronyssid ectoparasite that thrives in captive environments. Snake mite infestations of snakes and lizards may cause anaemia, skin irritation, or skin or corneal ulceration, while large infestations often cause dysecdysis. Snake mite infestations may also cause stress and may lead to secondary infections and slow recovery from other conditions. Poor husbandry practices are often conducive to mite infestations of captive stock (McCracken, 1988; Reiss, 1995). Some reports suspect snake mites are implicated in the transfer of Inclusion Body Disease, an introduced retroviral disease most common in pythons and boas.

The complete life cycle of *O. natricis* at 25°C takes between 13-19 days, with occasional specimens living for up to 40 days. Five stages exist: egg, larva, protonymph, deutonymph and adult. Females engorge on blood, fall off and lay up to 20 eggs in dark crevices. Eggs hatch in 28-98 hours. The larval stage lasts 18-47 hours, protonymph stage 3-14 days and deutonymph 13-26 hours. Blood meals are necessary at each nymph stage (Camin, 1953; Reiss, 1995).

Suspected snake mite infestations of reptiles caught in the field in the Melbourne area have been previously reported (Hoser & Valentic, 1995; Watharow, 1997). We suspect mites may have been introduced into the wild through released reptiles, particularly elapid snakes and blue tongue lizards.

Eastern Blue Tongue Lizards (*Tiliqua scincoides*) were surveyed for mites in two areas close to Melbourne: the Basalt Plains and the Diamond Valley region.

The Basalt Plains are covered by grasslands of introduced grasses and herbs, including *Nassella* sp., with basalt outcrops, man-made rock walls and often an abundance of loosely or deeply embedded scattered rocks. Originally, the grasslands were dominated by native species (*Themeda, Poa* and *Stipa* spp.). Rainfall in this region is generally lower than in other parts of metropolitan Melbourne.

The Diamond Valley region has a variety of habitat types, including riparian scrubland, and wet and dry sclerophyll forest. It is less disturbed than the Basalt Plains, but does include large and dense populations of exotic plant species, e. g. the grass *Nassella neesiana*, Scotch Thistles *Onopordum acanthium* and *O. nervosum*, Pampas Grass *Cortadertia jubata* and ivy *Hedera* sp.

The Eastern Blue Tongue is a terrestrial, heliothermic lizard and is a widespread species found throughout the eastern and northern Australian mainland (Cogger, 2000). It is very common in the Melbourne metropolitan area and is particularly abundant in disturbed habitats.

METHODS

Areas of western Melbourne known for their populations of *T. scincoides* were searched for lizards, especially during winter dormancy, between July 1999 and April 2000. Other blue tongues collected opportunistically during snake control operations across the Diamond Valley region were also examined. Areas were systematically searched by lifting rocks, iron sheets and grass root systems. Occasional individuals were captured basking near large outcrops.

Lizards were captured by hand, bagged in calico bags and then weighed (using electronic scales, to within 2 g), measured (snout-

vent length), and sexed by hemipene eversion. The lizards were then brushed for mites using a small bristle brush, attention being paid to regions around the limbs, eyes and ears. Mites were brushed into a funnel in a container with 70% alcohol. Lizards were then released back to their original location. Subsequent follow-up inspections of reptiles occurred in several cases.

Two lizards were brushed for mites after having been fatally injured and a third was brushed and then euthanased due to poor condition.

All equipment was sterilised using 5% bleach solution with subsequent mite spray (Orange Medic head lice treatment), as used in private reptile enclosures. Each paint brush was replaced regularly and containers only used once to prevent any contaminants and mistaken mite collection.

Mites were identified by Dr Dave Walter at the University of Queensland Department of Entomology (Walter & Shaw, 2002). The samples included both nymphs and adults. Mite specimens from lizards are deposited in the University of Queensland Zoology and Entomology Department and the Museum of Victoria.

RESULTS

A total of 28 blue tongue lizards were examined from ten sites in two regions of Melbourne (Fig. 1). These consisted of fifteen females, seven males and six of indeterminate sex. All but five juvenile to subadult Rockbank lizards were of medium to large size (SVL 215-280 mm, mean = 242.6 mm, sd = 18.9 mm; mass 108-410 g, mean = 273.1 g, sd = 76.5 g).

Eighteen lizards were infested by *O. natricis* and two lizards had mite faeces but no mites were detected. In the Basalt Plains region (Table 1), 78% of the 18 lizards examined carried mites, while in the Diamond Valley area (Table 2), 30% of the 10 lizards examined carried mites.

The Rockbank area yielded the highest numbers of lizards. This area also had the

Figure 1. Snout-vent length (mm) and sex of blue tongue lizards examined.

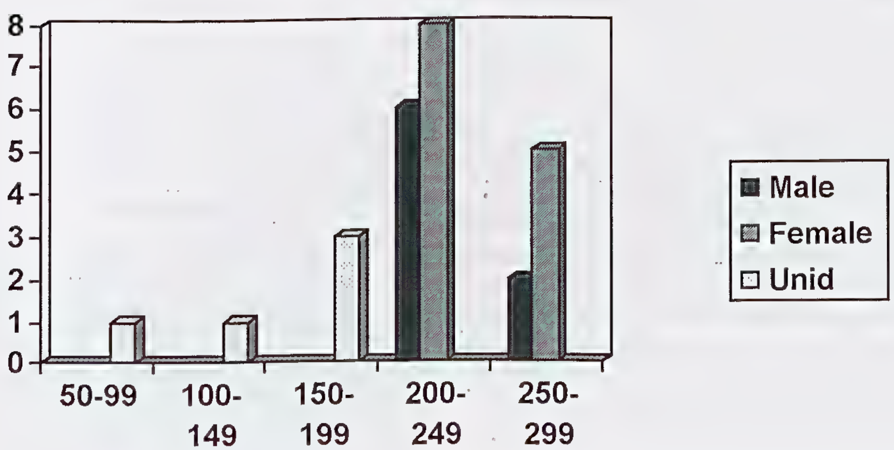

Table 1. Frequency of mite (*Ophionyssus natricis*) infestations on 18 blue tongue lizards (*Tiliqua scincoides*) from five localities in the western suburbs of Melbourne (Basalt Plains region).

Location	Latitude and longitude	No. of lizards	No. infested	Numbers of mites
Rockbank	37°43'S 144°38'E	10	8	5+ to 50+; one with faeces only
Melton	37°42'S 144°34'E	3	1	faeces only
Western Gardens	37°52'S 144°43'E	3	3	1 ad., 6 nymphs; 2 ad., 12 nymphs; 1 ad., 5 nymphs
Sydenham	37°41'S 144°45'E	1	1	1 mite
Thomastown	37°38'S 145°08'E	1	1	5+ mites
Total		**18**	**14**	

Table 2. Frequency of mite (*Ophionyssus natricis*) infestations on 10 blue tongue lizards (*Tiliqua scincoides*) from six localities in the Diamond Valley region of Melbourne.

Location	Latitude and longitude	No. of lizards	No. infested	Numbers of mites
Templestowe	37°40'S 145°07'E	3	1	50+ mites
Eltham	37°46'S 145°09'E	2	2	10+, 20+ mites
Lower Plenty	37°45'S 145°06'E	2	0	
Briar Hill	37°42'S 145°06'E	1	0	
Ivanhoe	37°46'S 145°02'E	1	0	
Yarrambat	37°38'S 145°07'E	1	0	
Total		**10**	**3**	

heaviest burdens of mite infested lizards. All lizards at this site were collected from a narrow fragmented corridor or open exotic grassland 2 km long and roughly 400 m wide at the widest point. This region was heavily disturbed with concentrations of rubble, concrete slabs, dumped rubbish and introduced vegetation. A small disused farm (now partly demolished) with sheets of iron widely scattered yielded several lizards. All locations in the Basalt Plains yielded at least one lizard carrying snake mites.

In the Diamond Valley region, three infested lizards were captured in yards, two near rock homesites and one in a suburban garden.

DISCUSSION

Clearly blue tongue lizards in several habitat types around the Melbourne metropolitan area are infested with snake mites. Infestations of snake mites occurred with heavy burdens up to an estimated 50+ mites, while some lizards demonstrated abundant mite faeces (whitish flecks) despite no mites being found. Collections of mites commonly occurred around the eyes, limbs, cloaca, and under obviously raised scales.

The numbers of snake mites collected and the range of habitats and areas they were present in provides definitive evidence of widespread infestation in these two areas. Lizards recorded with the larger burdens (especially of nymphs) in the cooler months may be the result of easy access to dormant lizards for blood meals.

It seems unlikely that lizards can lose the mites permanently by sloughing, basking or experiencing extreme weather conditions in summer or winter. Three lizards were observed dormant over a three month period until they moved away. Two other lizards were repeatedly located over nine months to ascertain whether the mite presence remained, and only in late summer were they observed with mite faeces but no mites.

Frequent and controlled release, translocation and removal of snakes and lizards through local snake control, pet trade, wildlife shelter operators and scientific studies have possibly extended the infestation to other areas. Exactly which areas are infested and whether any sensitive areas like National and State Parks or conservation areas needs to be assessed urgently. This study highlights the need for greater disease prevention protocols on future relocations and in studies involving reptiles (Viggers *et al.*, 1993).

In captivity, numerous species have been infested with these mites. However, in the field, reptiles with large, overlapping scales, such as elapids and large skinks, are perhaps most at risk. Snake mites need a warm and humid environment with dark cracks or places to hide in. Whether they can become established in natural situations with few man-made changes remains unclear.

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DIETS OF THREE LARGE ELAPID SNAKES FROM THE MELBOURNE METROPOLITAN REGION

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INTRODUCTION

Although a number of prey items have been previously reported from elapid snake species, most previous studies have pooled data from snakes obtained from a number of different habitats, and few have considered changes in the diet of snakes inhabiting heavily modified urban environments.

Large elapid species feed on a variety of prey types, and it has been suggested that introduced rodents (House Mouse *Mus domesticus* and Black Rat *Rattus rattus* particularly) occur in artificially increased numbers in agricultural areas. These rodents comprise a major food resouce for snakes in such situations (Mirtschin & Davis, 1983; Gow, 1989; Shine, 1989, 1991; Watharow, 1997; 1999), reducing the intake of ectothermic prey in these environments.

Seven species of elapid snakes are still present in the Melbourne metropolitan area, including three large species, the Eastern Tiger Snake *Notechis scutatus*, the Lowland Copperhead *Austrelaps superbus* and the Eastern Brown Snake *Pseudonaja textilis* (Coventry & Robertson, 1991; Watharow, 1997, 1999, 2001). Snakes sighted around residences are generally regarded as undesirable, and can be removed by licensed snake catchers. Under licence conditions (pre-1999), such snakes must be euthanased, and this allows data to be gathered on dietary items. Some data on Tiger Snake and Copperhead stomach contents from snakes collected between September 1995 and April 1996 were provided by Watharow (1997). This paper reports additional prey items from these two species, and from the Eastern Brown Snake, obtained from snakes collected from Melbourne residential areas in the following year (September 1996 to April 1997).

METHODS

Live snakes were removed from residential areas and euthanased by licensed snake catchers under wildlife controller licences from over 35 metropolitan areas, according to the regulations operating at the time. Additional snakes, fatally injured by dogs, humans or for other reasons, were also obtained.

All snakes were measured (snout-vent length +/- 5 mm), weighed (+/- 1 g) and sex determined either by sexing probes or by dissection. Stomach contents were removed and examined, then preserved in 10% formalin. Prey items were identified to species where possible.

RESULTS

Stomach Contents

A total of 62 snakes were obtained during the 1996-97 season: 28 *Notechis scutatus*, 26 *Austrelaps superbus* and 8 *Pseudonaja textilis*. Physical data on these snakes are provided by Watharow (2001). Of these, 6 *Notechis scutatus* (21.4%), 11 *Austrelaps superbus* (42.3%) and 6 *Pseudonaja textilis* (75.0%) had stomach contents. Details of stomach contents are provided in Tables 1-3.

Behavioural observations

Notechis scutatus

Tiger snakes were commonly removed from inside residences and from off-ground situations, including kitchens, bedrooms, laundries, wardrobes, roof guttering and garages, and were frequently discovered inside compost bins. Snakes were also removed from trees with bird nests, or from bird cages, aviaries and chicken pens. Snakes were found inside captive bird nesting boxes both at night and by day.

Table 1. Dietary data for *Notechis scutatus* removed from around residences in Melbourne. Snake number refers to records from Watharow (2001), where physical data are provided.

Number	Locality	Stomach contents	Notes on prey items
4	Langwarrin	1 House Mouse *Mus domesticus*; 1 Canary *Serinus canaria*	adults
5	Frankston	1 Passerine bird	nestling
7	Mt Eliza	4 House Mice *Mus domesticus*	adults
12	Donvale	2 House Mice *Mus domesticus*	pups
15	Lower Plenty	Paper and mouse hairs	
28	Eltham	1 House Mouse *Mus domesticus*	adult

Table 2. Dietary data for *Austrelaps superbus* removed from around residences in Melbourne. Snake numbers refer to records from Watharow (2001), where physical data are provided.

Number	Locality	Stomach contents	Notes on prey items
1	Pakenham	1 Pobblebonk Frog *Limnodynastes dumerilii*	adult
3	Keysborough	8 lizard (skink) eggs	
4	Narre Warren	1 Weasel Skink *Saproscincus mustelinus*; 17 lizard eggs	adult skink
5	Ferntree Gully	3 Garden Skinks *Lampropholis delicata*; 12 lizard eggs	skinks represented by tails only
9	Cockatoo	1 Weasel Skink *Saproscincus mustelinus*; 1 Garden Skink *Lampropholis delicata*	Garden Skink adult; Weasel Skink represented by a tail
12	Seaford	1 Frog *Limnodynastes* sp.	adult
13	Gisbourne	2 White-Lipped Snakes *Drysdalia coronoides*	adults
15	Frankston	frog remains	
19	Knox	1 Garden Skink *Lampropholis delicata*	adult
23	Frankston	1 Garden Skink *Lampropholis delicata*	adult
25	Pakenham	2 Weasel Skinks *Saproscincus mustelinus*; 1 Garden Skink *Lampropholis delicata*	adults; one Weasel Skink represented by a tail

Table 3. Dietary data for *Pseudonaja textilis* removed from around residences in Melbourne. Snake numbers refer to records from Watharow (2001), where physical data are provided.

Number	Locality	Stomach contents	Notes on prey items
1	Research	1 House Mouse *Mus domesticus*	adult
2	Warrandyte	3 House Mice *Mus domesticus*	adults
4	Diamond Creek	1 House Mouse *Mus domesticus*; 1 Garden Skink *Lampropholis delicata*	both adults
6	Eltham	1 Eastern Bluetongue Skink *Tiliqua scincoides*	juvenile
7	Taylors Lake	1 House Mouse *Mus domesticus*	adult
8	Panton Hill	1 skink *Lampropholis* sp.	adult

Austrelaps superbus

Copperheads were observed probing rock crevices, timber retaining walls and foraging through vegetation.

Pseudonaja textilis

Brown snakes forage widely, often investigating areas of human habitation, including sheds, horse stables, farm yards and domestic bird enclosures, and occasionally enter houses and garages. However, they are also quick to flee from disturbance, due to their highly alert and nervous disposition.

DISCUSSION

The results of the 1996-1997 season are compared with the 1995-1996 season (Watharow, 1997) in Table 4 (no dietary items were recorded for *Pseudonaja textilis* in 1995-1996). The results of the two years are similar. In both years, prey items for *Notechis* were all endotherms, while prey items for *Austrelaps* were mostly ectotherms. Only mice and lizards were present in the *Pseudonaja* examined in 1996-1997. All prey items found are common in metropolitan areas. The diet of each species is reflected in its behaviour – *Notechis scutatus*, which was the most arboreal of the three species, was the only one of the three snakes to eat birds, while both *N. scutatus* and *P. textilis*, which entered human habitations, consumed mammals, which are common around dwellings. In contrast, *Austrelaps* ate mostly native reptiles and frogs, with its observed foraging behaviour occurring in sites that commonly harboured these prey items.

The endotherm-high/ectotherm-poor diet of *Notechis scutatus* in the Melbourne metropolitan area is different to mainland populations previously studied. Shine (1987a) reported a high proportion of frogs in the diet of *Notechis* in New South Wales, Victoria, South Australia and Western Australia, with between 50-81% of snake food items being frogs, although mammals dominated in the Tasmanian population (Fearn, 1993). In contrast, in five years of snake control in Melbourne, with 81 *Notechis* dissected, only one was found containing frogs (two *Limnodynastes tasmaniensis*) (pers. obs.). Melbourne *Notechis* were often removed from areas of rodent infestation (pers. obs.), and this high prey availability may influence the diet of snakes in this region. The birds in the diet of *Notechis* may be eaten for two reasons. Firstly, *Notechis* may be initially attracted to the avian enclosures due to

Table 4. Diet comparison of *Notechis scutatus* and *Austrelaps superbus* between 1995-96 (data from Watharow, 1997) and 1996-97.

	Notechis scutatus		*Austrelaps superbus*	
Prey Type	**1995-96** (n = 8)	**1996-97** (n = 6)	**1995-96** (n = 6)	**1996-97** (n = 11)
Miscellaneous		16.6%		
Frogs			50.0%	27.2%
Lizards			16.6%	54.5%
Lizard Eggs			16.6%	27.2%
Snakes				9.0%
Birds	25.0%	33.3%		
Mice	50.0%	66.6%	16.6%	
Rats	25.0%			

mouse infestations in tunnels under or in the enclosures. Secondly, they are more arboreal than the other two species (Webb, 1981), and hence more able to capture birds in the enclosures. In the Melbourne area, tiger snakes have been observed climbing small shrubs and trees around residences to prey on bird nestlings, particularly passerines (e.g., Blackbird, *Turdus merulus*; pers. obs.). However, they do not appear to consume avian eggs.

The predominance of small or slender ectothermic prey (frogs, small lizards, lizard eggs and snakes) in *Austrelaps* in Melbourne is similar to the diet reported elsewhere (Shine, 1987b; Fearn, 1994). The single endotherm prey record from my studies, from the 1995 - 1996 sample, was in a large copperhead (SVL = 1100 mm) that had been inadvertently caught in a large drum – whether the predation occurred opportunistically after the snake was trapped, or the snake deliberately hunted the mouse is unknown. Why copperheads do not feed more commonly on mice in the wild is not known, as they are often maintained on a mouse diet in captivity (pers. obs.). Maybe the lower preferred temperature of this species does not favour the capture or consumption of large prey. Fearn (1994) noted that the jaw structure of this species is limiting to large prey items, and that more mammals were eaten by the larger Tasmanian and King Island copperheads than by mainland copperheads, suggesting that only large snakes can feed on mammals. Lizard eggs were a major dietary element in copperheads in Melbourne. The eggs found in copperhead stomachs were in good condition and intact, as were non-gravid skinks found in the same stomachs, indicating that the snakes consumed the eggs directly rather than eating gravid female skinks. The number of eggs present in individual snakes suggests that the snakes had eaten eggs from communal nests.

Brown snakes have previously been reported to feed on a wide range of prey items, and all the prey species reported here, including *Tiliqua* species, have been previously reported (Shine, 1989; Roberts & Mirtschin, 1991; Armstrong & Reid, 1992; Bull, 1995). Although the sample size is small, the dominance of mice in the diet in disturbed areas is in agreement with previous observations (Shine, 1977; Mirtschin & Davis, 1983; Ehmann, 1992; Watharow, 1998).

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NOTES ON THE CAPTIVE BREEDING OF THE SWAMP SKINK (*EGERNIA COVENTRYI*)

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The Swamp Skink *Egernia coventryi* is a medium-sized terrestrial skink, reaching a snout-vent length of 100 mm and a total length of 250 mm (Robertson, 1998). It inhabits low-lying marshes and lagoon margins, often in association with vegetation that consists of *Melaleuca* or *Leptospermum* thickets and various sedges. Restricted to cool humid areas, its range extends from south-eastern South Australia, through southern Victoria to the extreme south-eastern corner of New South Wales (Wilson & Knowles, 1992; Cogger, 2000). Predominantly diurnal, it shelters beneath logs, dense low vegetation and will often utilise abandoned crustacea burrows (Wilson & Knowles, 1992). All *Egernia* species are viviparous, and swamp skinks give birth to up to six young (commonly three) during late January and February (Clemann, 2000). Young weigh slightly more than 1 g at birth (Robertson, 1999) and have a SVL range of 31-41 mm (Douch, 1994; Robertson, 1999). However Schulz (1992) recorded a neonate SVL of up to 50 mm, and a total length of 90 mm.

The swamp skink is listed as rare in Victoria, mainly due to habitat modification or loss (Stanger *et al.*, 1998). It was because of one particular habitat disturbance, the construction of a mains water pipeline by Melbourne Water Authority through Tootgarook Swamp, that Healesville Sanctuary first became involved. The area contained a significant colony of this species, so along with Melbourne Water and the Department of Natural Resources, a plan was conceived to catch as many skinks as possible from along the proposed pipeline before the work commenced. Healesville Sanctuary's role was to hold these skinks until the work on the pipeline was completed and the swamp had revegetated; most of the skinks would then be returned. A small number would remain in captivity as future exhibit animals, thus raising awareness of this species to the public and to provide a captive-breeding group (Taylor, 1994, 1995).

Since 1994, Healesville Sanctuary has been successful in maintaining and breeding the swamp skink in captivity. The following data has been collected from a single adult female over four consecutive years. Except when this female has been caught up, her entire time is spent out doors in a large circular pit. This is a galvanised structure (as used for water tanks), measuring 3 m in diameter x 1.1 m in height. Vegetation within the enclosure consists of a dense layer of sedges; and furnishings include a number of logs and a water bowl (Figure 1). Our stocking policy usually consists of two adult males and two adult females per enclosure. It has been recorded that swamp skinks can be quite aggressive towards conspecifics, resulting in severe injuries and even death if too many adults are housed within the same enclosure (Taylor, 1995).

On January 19 1999, a five year old captive-born swamp skink was observed to be gravid. She was caught up and placed into a suitable holding facility within the Sanctuary's Reptile House so that breeding information could be collected. This enclosure measured 400 mm wide x 580 mm long x 420 mm high and contained a gravel substrate, with numerous pieces of bark and small logs. It also contained a small water dish and had a UV fluorescent light overhead. Her gravid weight was 28.4 g (SVL = 94 mm, total length = 244 mm, tail intact). During 29-30 January 1999, this female gave birth to six young. Weights and mor-

Figure 1. One of our outside enclosures, set up for housing *Egernia coventryi*.

phological measurements were recorded for the six newborn skinks (Table 1) using an electronic balance scale (to 0.1 g accuracy) and a clear plastic ruler. The female's post-partum weight was 21.6 g (a loss of 6.8 g from gravid weight).

On December 20 1999, this female was observed to be gravid. As before she was collected to record breeding information (all adult reptiles within our collection are identifiable by a Trovan transponder implanted under the skin). The female's gravid weight was 27.8 g (SVL = 94 mm, total length = 246 mm, tail intact). During 29-30 January 2000, this female gave birth to six live young; again morphological measurements and weights were recorded (Table 1). The female's post-partum weight was 19.3 g (a loss of 8.5 g from gravid weight).

On 21 January 2001, this female was again gravid. She was caught up and held in a suitable holding facility until she gave birth. Her gravid weight was 25.9 g (SVL = 95 mm, total length = 247 mm, tail intact). This year she gave birth to one live young on 25 January 2001 with three more found the following day. The four young were weighed and measured (Table 1); the female's post-partum weight was 19.2 g (a loss of 6.7 g from gravid weight).

On 15 January 2002, this female was caught up and again held in a suitable holding facility. Her gravid weight was 27 g (SVL = 95 mm, total length = 247 mm, tail intact). On 31 January 2002, she gave birth to two live young with three more born the following day. All were weighed and measured (Table 1); her post-partum weight was 19.8 g (a loss of 7.2 g from gravid weight).

The average weight of the twenty-one young over the four year period was 1.1 g (SD = 0.1), average SVL was 37 mm (SD = 1.3) and average total length was 90 mm (SD = 2.9).

Table 1. Mean lengths and weights of newborn swamp skinks (*Egernia coventryi*) produced by a single female over four years. Lengths are in millimetres (mm) and weights are in grams (g).

Date of birth	Number	Mean snout-vent length (SD, range)	Mean total length (SD, range)	Mean weight (SD, range)
29-31 Jan 1999	6	36 (0.6, 35-37)	89 (3.8, 85-96)	1.0 (0, 1.0-1.1)
29-30 Jan 2000	6	38 (0.5, 38-39)	91 (2.2, 88-94)	1.0 (0, 1.0-1.2)
25-26 Jan 2001	4	38 (0.5, 38-39)	91 (0.5, 91-92)	1.1 (0, 1.1)
31 Jan-1 Feb 2002	5	37 (1.4, 35-38)	89 (3.0, 86-93)	1.1 (0.1, 1.0-1.2)

My data on newborn lengths and weights are similar to those recorded by Douch (1994) and Robertson (1999); however the SVL is substantially shorter than the 50 mm recorded by Schulz (1992). *Egernia coventryi* are seasonal breeders and females give birth to a single brood each year from late January through to February. The single female in this article has given birth over the same narrow time period (eight days) from 25 January to 1 February during the four years that breeding data was collected. This female was born in captivity on 7 February 1994. At the time of the fourth breeding in January 2002, she was eight years old and thus gives some indication of the longevity of this species.

Healesville Sanctuary has in the past seven years been successful in breeding over fifty *E. coventryi* in captivity, with many of these being made available to other wildlife organisations. Since the reintroduction of the core group back into the pipeline area of Tootgarook Swamp in November 1994, our involvement with this species now consists in maintaining a viable captive group for display to the public. We have always maintained a strong conservation message, and by utilising species such as *E. coventryi* we can raise awareness in the community about the impact that our society is having on the environment and the species that live within it.

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THE EASTERN BLUETONGUE SKINK *TILIQUA SCINCOIDES* IN THE SYDNEY METROPOLITAN AREA: THE GREAT SURVIVOR, OR JUST HANGING ON?

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ABSTRACT

Comparison of historical records for the period 1867-1960, and wildlife rescue data for the period 1994-1998 suggest that the overall distribution of bluetongue lizards (*Tiliqua scincoides*) has not decreased in the Sydney metropolitan area, despite the long period of urban development. The wildlife rescue data is not evenly distributed: higher numbers of bluetongues are reported from discrete areas, including the Northern Suburbs, the Northern Beaches, the suburbs along the north and south sides of the Georges River, and to a lesser degree, the Eastern Suburbs. Survival of bluetongues in the Sydney metropolitan area may be due to and dependent upon the existence of corridors of dense vegetation and shelter sites in suburban gardens, large suburban blocks, the distribution of traffic movements and the availability of introduced food species. We recommend the permanent archiving of data gathered by volunteer wildlife rescue groups.

INTRODUCTION

Urbanisation is generally regarded as having deleterious effects on native fauna, with the loss and fragmentation of natural habitats and resources, and increased mortality by new predators (Recher, 1972; Dickman, 1987; Andrews, 1990; Recher *et al.*, 1993; Keast, 1995). In Sydney, although 28 species of lizard have been recorded from the coastal plain in the Sydney metropolitan region (Griffiths, 1997), only a few species of skink remain in heavily urbanised suburbs (Greer, 1989). The loss is especially noticeable among the larger reptile species, with both varanids, the two large agamids (Lunney, 1986), and large pythons and elapids largely lost from most densely settled areas of Sydney. The prominent exception to this trend is the Eastern Bluetongue Skink, *Tiliqua scincoides*. This large skink (adult snout-vent length about 300 mm; adult mass about 500 g) is usually considered to remain common in suburban gardens in large cities within its distribution (McPhee, 1959; Swan, 1990), including Brisbane (Wilson & Czechura, 1995), Sydney (Cogger, 1962; Clark & Recher, 1973; Green, 1973; Wells & Wellington, 1989; Griffiths, 1990, 1997), Canberra (Bennett, 1997) and Adelaide (Tyler *et al.*, 1976), and is by far the largest of the skink species surviving in Sydney urban environments.

Although the observation that bluetongues have survived urbanisation is commonly made, there are few data to support the claim. Like most urban populations of native fauna, there are no studies of changes in population density over time for the Eastern Bluetongue in Sydney or in other urban areas.

The value of museum records in determining historical distributions is well-known (Main, 1990), but the rise in recent years of volunteer wildlife rescue organisations has provided a potential new source of baseline data on contemporary distributions.

This paper reports historical data on the occurrence of bluetongues in the Sydney region, using museum records and literature records, and compares the known historical distribution to current distribution as determined from the database of fauna rescues in the Sydney region by a major wildlife rescue

organisation, WIRES (Wildlife Information and Rescue Service).

MATERIALS AND METHODS

Historical Records

All records of *Tiliqua scincoides* from the Sydney area prior to 1960 were extracted from the Australian Museum registers. Records post 1886 were searched electronically, but earlier records, held in the "A" and "B" registers, as early as 1875, had to be extracted by hand. Literature records were obtained from an unpublished bibliography of literature on *Tiliqua* and *Cyclodomorphus* compiled by the senior author over a 20 year period (Shea, 1992). A cut-off date of 1960 was chosen as representing the early stages of the rapid post-war expansion of suburban Sydney (Keast, 1995).

WIRES Data

Data on bluetongue rescues during the period July 1994 to April 1998 were obtained from WIRES. A total of 1891 records of the site of observation/collection of injured or

Figure 1. Historical records of *Tiliqua scincoides* from the Sydney region prior to 1960 based on museum records (dots), with additional literature records (squares). Dashed line represents approximate limit of Sydney suburbs in 1940s, based on the list of recognised suburbs in Wise (1947).

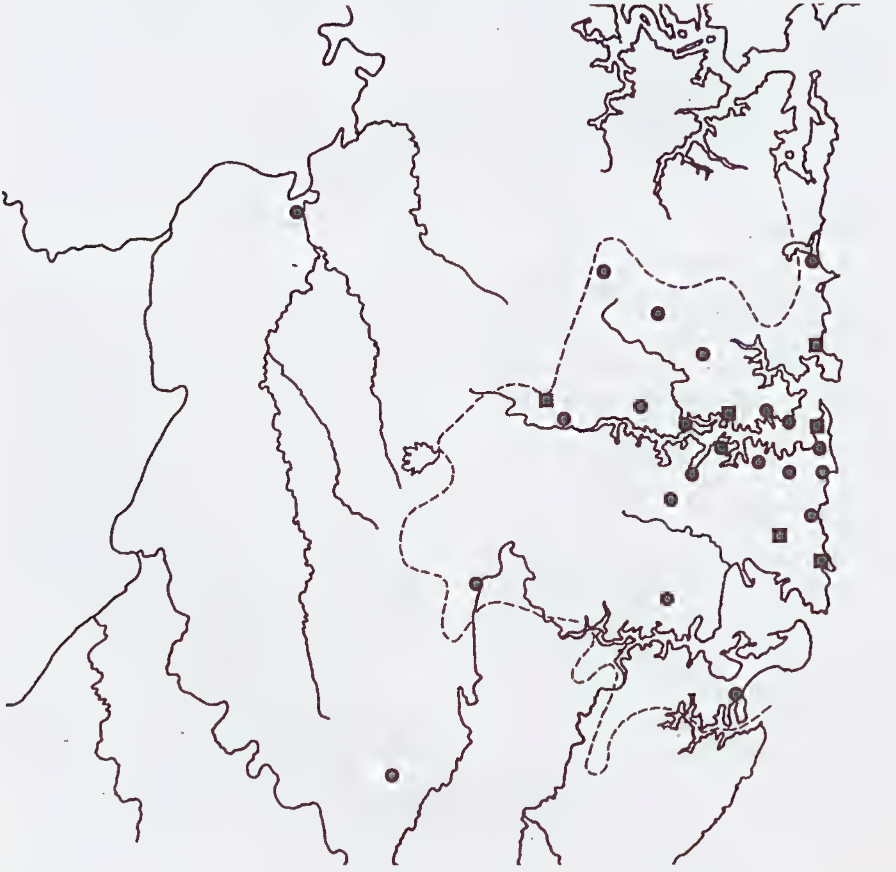
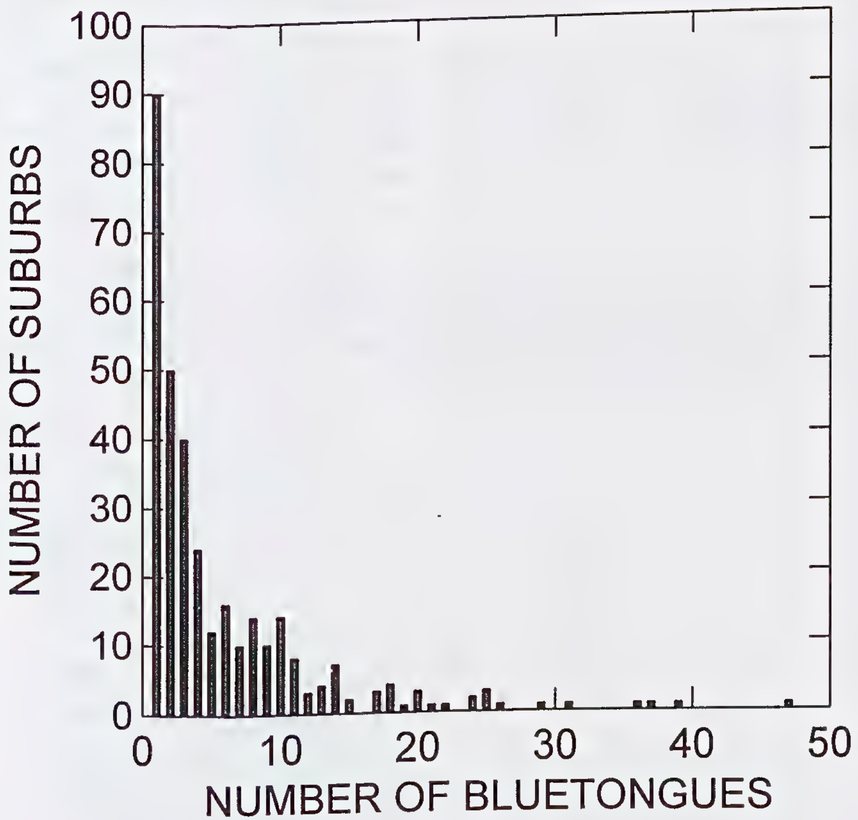


Figure 2. Frequency of bluetongue rescues per suburb in the Sydney region by WIRES over the period July 1994 to April 1998. Suburbs with no reported bluetongue rescues not included.



potentially threatened lizards, identified to suburb, were obtained from the Sydney metropolitan area.

RESULTS

Historical Records

Museum records of *Tiliqua scincoides* from the Sydney region were obtained for 22 suburbs or localities (Fig. 1). The most recent record during the period searched was from 1930 – there were no records for the period 1931-1960. An additional six localities (Fig. 1) reported in the literature from before 1960 were identified: Long Bay (Krefft, 1867), Manly (Flynn, 1923), Eastlakes Golf Course (Mackay, 1949), Vaucluse (Nathan, 1952), Lake Parramatta (Anon, 1959) and Wollstonecraft (Keast, 1995).

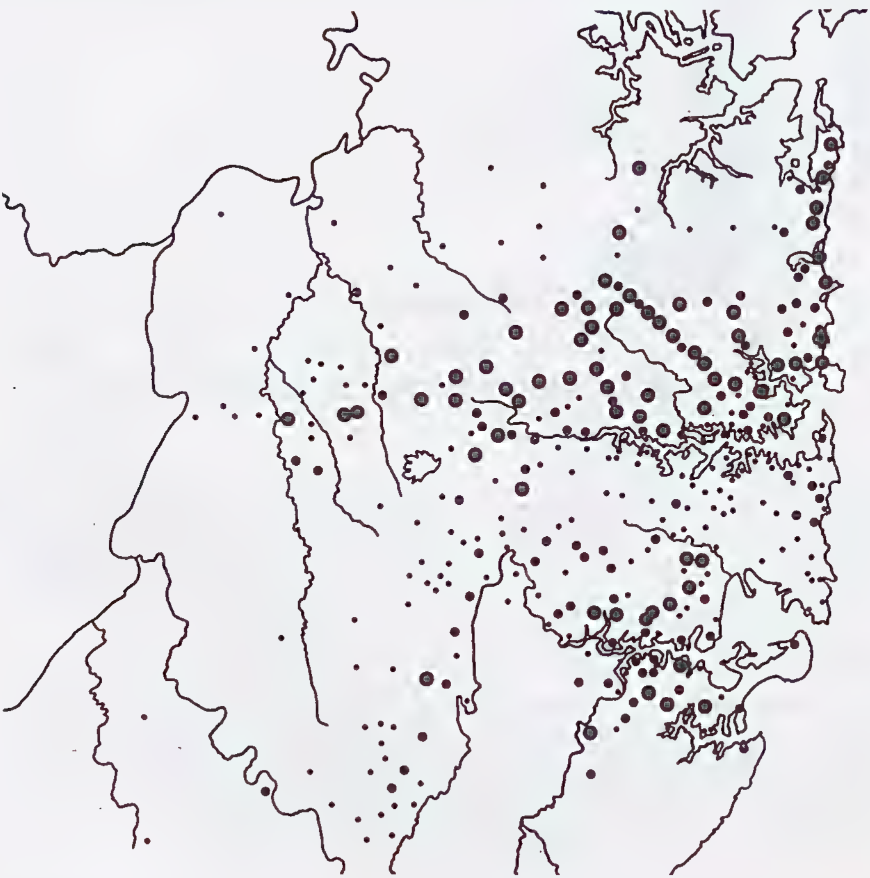
The majority of these records were within the Sydney metropolitan region in the 1940s (list of Sydney suburbs from Wise, 1947), with only Campbelltown (one record from 1894) and Windsor (one record from 1877) being outside the limits of the Sydney urban development of the period (Fig. 1).

WIRES Data

Bluetongues were rescued from 329 suburbs. The number of bluetongue rescues from suburbs ranged from 1 to 47 (Fig. 2), with a mode of one (27% of cases). Twelve suburbs were notable for large numbers of rescues: Blacktown, Chatswood (24), Castle Hill, Eastwood, Ryde (25), Forestville (26), Lane Cove (29), Wentworthville (31), Hornsby (36), Carlingford (37), Epping (39) and Baulkham Hills (47).

Although bluetongues were rescued from most parts of Sydney, the distribution of bluetongue rescues showed obvious geographic clustering (Fig. 3). Suburbs with ten or more bluetongue rescues during the four-year period were almost all located in four areas: north of the harbour, including the periphery of the Lane Cove Valley and the southern and western fringes of Ku-rin-gai Chase National Park, and extending west in a band to St Marys (hereafter referred to as the Northern Suburbs group); the Northern Beaches area

Figure 3. Distribution of bluetongue rescues by WIRES in the Sydney region over the period July 1994 to April 1998. Dot size represents number of bluetongues rescued: small dots – 1-3 rescues; intermediate dots – 4-9 rescues; large dots - >9 rescues.



from Manly, Balgowlah and Seaforth in the south to Avalon in the north; the strip of suburbs between the Georges River and the southern National Parks (Heathcote and Royal National Parks), hereafter referred to as the Southern Suburbs group, and an arc from Padstow north-east to Eastwood and Arncliffe, north of the Georges River (hereafter referred to as the Hurstville group). Suburbs with medium numbers of rescues (4-9 rescues during the four-year period) mostly occurred in close proximity to those with high numbers of rescues, joined the Northern Beaches region to the Northern Suburbs group, and extended the Hurstville group further northwest to the Bankstown region. Two additional clusters of suburbs with medium numbers of bluetongues were apparent: a small Eastern Suburbs group (Edgecliff to Coogee) and a long band along the west side of the upper Georges River, from Cabramatta south to Campbelltown (the Campbelltown group). Suburbs with few rescues (1-3 rescues during the four-year period) were mostly outside these six areas, and particularly in a band between the Parramatta River and the Hursville group, and north-west of the Northern Suburbs group. There were few urban areas with no bluetongue rescues reported, other than large areas of heavy industry. Other regions with no bluetongue rescues in the Sydney region were either reserved bushland areas lacking urban development (National Parks, State Forests, Recreation Reserves, State Recreation Areas, Military Reserves, Water Catchment Reserves and large parklands under local government control), or small recent urban developments surrounded by farmland and pasture (south-west and north-west corridors).

DISCUSSION

The data suggest that bluetongues still occur throughout the Sydney metropolitan area, even in most areas that have been suburbs for over half a century.

It is possible that some of the rescue records represent escaped pets, as bluetongues are widely kept in captivity. This practice began at least as early as 1926 in Sydney (Blacket, 1926), and until 1974, when reptiles became protected fauna, they were commercially available in the pet trade in New South Wales. Licencing of captive reptiles recommenced in New South Wales in 1997, and in 2001, there were 2192 *T. scincoides* registered by the National Parks and Wildlife Service as being held in private hands in the state (J. Hardy, pers. comm. 12.iii.2002), the majority in the Sydney area. However, it is likely that most of the registered lizards are held in confinement, with collection and transfer of non-captive lizards having been illegal for over two decades. We are unaware of any evidence from the registered bluetongue database of a significant problem with loss of animals due to escape or release (although undoubtedly some keepers still operate outside the law). Hence, suburbs represented by reasonable numbers of rescues probably hold established populations rather than large numbers of escaped pets, and we consider that even those suburbs represented by only 1-3 animals over the four year period are likely to be represented mostly by non-captive animals.

Taking into account the paucity of historical records, the modern distribution of bluetongue rescues is similar to the historical data. Of the historical records from within the Sydney suburban limits of 1947, most are from areas or single suburbs that are still represented by medium to high numbers of bluetongue rescues. Similarly, the majority of modern records (73% of 329 suburbs) are within urban areas that have been present since the 1940s, and often much earlier. The only large modern areas with medium to high numbers of bluetongue rescues that were not recognised as Sydney suburbs in the 1940s are the western parts of the Northern Suburbs group, from Westleigh to St Marys, and (with lower numbers of bluetongue rescues), the Campbelltown

group. Even these areas had numbers of farms and smaller settlements at that time (Wise, 1947).

The number of bluetongue rescues from a suburb may reflect the size of the local population in that suburb. We infer that those suburbs with very large numbers of bluetongue rescues and that have been Sydney suburbs for over half a century, must have a large and reproducing population of bluetongues in order to sustain long-term mortality. This assumes that there has been no sudden increase in the injuries in such suburbs. The majority of WIRES rescues are performed because of cat, dog or motor vehicle injuries (Koenig *et al.*, 2002), and we are unaware of a recent abrupt major increase in either ownership of cats and dogs, or of vehicular traffic as a general pattern in the suburbs concerned.

Suburbs with few bluetongue rescues may have few bluetongues present, or the low number of rescues may be due to unavailability of WIRES volunteers to rescue animals from such areas. We consider the latter possibility less likely. There are few urban areas from which bluetongue rescues are entirely lacking, suggesting that there are few areas where WIRES volunteers are unable to attend. Hence, the pattern of bluetongue rescues should reflect, in part, the real density of bluetongues occurring in that region. Nonetheless, we accept that a number of factors can affect the number of bluetongue rescues independently of bluetongue population size. For example, the apparent lower number of rescues in the far western suburbs of Sydney probably does not reflect a real paucity of bluetongues in this region. The density of housing and roads in these regions is much lower than in the inner Sydney suburbs, and there are fewer barriers to bluetongue movement, lower densities of pet cats and dogs, and fewer people to report injured bluetongues to WIRES. Bluetongues have been reported to be abundant in this region (Wells & Wellington, 1989).

Why bluetongues remain more common in some areas of Sydney than others remains unknown. One factor which may influence urban bluetongue populations is the proximity of natural bushland which could serve as a reservoir, allowing continual replenishment of urban populations. Certainly, the Northern Suburbs and Northern Beaches populations are close to three large reserve areas, Ku-rin-gai Chase National Park, Lane Cove River National Park and Davidson Park State Recreation Area. Similarly, to the south, the Southern Suburbs group borders Royal and Heathcote National Parks. However, the Hurstville group does not border large natural bushland reserves, and is separated by the Georges River from National Parks. Similarly, the Campbelltown and Eastern Suburbs groups are not close to large bushland reserves. Further, this argument assumes that bushland reserves continue to support large natural populations of bluetongues available to disperse into surrounding suburbs, an assumption that remains to be tested.

Other factors which may influence bluetongue numbers relate to the ecology of the species. Koenig *et al.* (2001) studied movements of adult *T. scincoides* at two sites in the Northern Suburbs region, and concluded that the survival of bluetongues in urban environments was due in part to the reliance of both sexes, but especially the critical reproductive females, on distinct repeatedly-used shelter sites within a broader home range, together with corridors of thick vegetation (gardens and fence lines) between these sites that facilitated safe movement between refugia. They further noted that bluetongues avoided crossing roads; that the peak lizard activity period had minimal overlap with human activity in the residential sites studied, and that the diet was opportunistic, but included large numbers of introduced prey species, particularly snails.

These data allow us to make the following testable predictions. Within the long-settled suburbs of Sydney, regions with high

numbers of bluetongue rescues (and hence by inference dense bluetongue populations) should have:

1. greater vegetation cover, particularly in the form of gardens;

2. fewer roads (and hence larger suburban blocks);

3. lower traffic loads and a pattern of peak traffic movements outside of the middle of the day (i.e., they should be predominantly residential rather than commercial or industrial), and

4. greater food resources (particularly garden snails),

than regions with low numbers of bluetongue rescues (with sparse bluetongue populations).

Our data also demonstrate the value of record-keeping by wildlife rescue organisations. We encourage the development of such databases, and recommend their formal permanent archiving for future generations of researchers.

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BACK-FILLING OF A BURROW ENTRANCE BY A SUBADULT *VARANUS GOULDII*

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INTRODUCTION

Many Australian ground-dwelling lizards (eg. agamids, skinks, geckos and monitors) utilise burrows to provide permanent shelter and as a retreat from predators (Greer, 1989). Specimens of some species construct their own burrows. Others occupy the burrows of other animals, often invertebrates (Greer, 1989; Lawless, 1995). Ties to a home burrow can be strong (Jackson, 2001) and active defence of the burrow has been observed (Henle, 1989). The protective nature of a burrow can be further enhanced if it is back-filled when the lizard is `in residence'. Back-filling of burrows has been reported for some dragons (*Ctenophorus clayi, C. nuchalis, C. pictus* and *C. salinarum*; Greer, 1989), some geckos (*Nephrurus levis, N. stellatus*; Greer, 1989) and a skink (*Ctenotus severus*; Gaikhorst, 1998).

To date, there are no published accounts of Australian varanids back-filling their burrows. However, this has been recorded in Asian species (*V. bengalensis* and *V. flavescens*; Auffenberg, 1994), during winter months. We report observations (PJC & JAC) of such behaviour by a wild specimen of *Varanus gouldii* at the Yuleba Caravan Park (26°36'S, 149°16'E), southeastern Queensland, on 22-23 March, 1995.

OBSERVATION

A subadult *Varanus gouldii* had been seen, during the first day, foraging in the camping ground. There was no opportunity to measure the specimen, but total length was estimated to be approximately 60 cm. At 1530h, it was seen sunning near its burrow entrance, which faced north. The burrow was constructed in sandy soil, beneath a timber telegraph pole that was lying on the ground. The telegraph pole formed the upper edge of the burrow entrance, which was narrow and crescent-shaped. We did not see the goanna enter its burrow, but it apparently did so at approximately 1620h. Shortly after, the burrow entrance was examined. It was blocked with freshly disturbed sand. No further activity was seen for the day.

Next morning, the goanna's activities were monitored closely. Although the burrow entrance was in full sunlight by 0705h, the goanna did not emerge until 0800h. The burrow entrance remained open during the day. The goanna was periodically seen, stationary in a sunning posture, or active. It entered its burrow at 1630h. The burrow was blocked quickly (< 1 min) by the goanna , which filled the entrance with loose sand using the tip of its snout as a `plough'.

To determine the extent of this behaviour in the local *V. gouldii* population, an area containing numerous *V. gouldii* burrows was searched in nearby Yuleba State Forest. The area was first inspected during daylight hours. Identification of the burrow residents as *V. gouldii* was confirmed by tail impressions in the loose sand at the burrow entrances. These traces were made by adult-sized goannas. The shape and frequency of the large, circular entrances suggested they were part of an abandoned rabbit warren, subsequently occupied by goannas. Use of rabbit warrens by *V. gouldii* is well-known (King & Green, 1999). The site was visited again at dusk of the second day of observations (23 March). Of some 20 burrows examined, none was found with back-filled entrances. However, specimens of *V. gouldii* usually have several burrows. During the active season, the goannas move between burrows, generally not occupying a single burrow for more than a few nights (G. Swan,

pers comm.; Green & King, 1978). With this in mind, there is a small possibility that none of the burrows was occupied when examined. This seems unlikely, as several adult specimens were encountered earlier in the day, in the immediate area. Further, the impressions in the sand at the burrow entrances were fresh, with perfect definition.

DISCUSSION

Whether the goanna at Yuleba Caravan Park routinely back-filled its burrow entrance is not known. The observed behaviour may simply have been a response to our presence. Our tents were pitched close to its burrow (<10 m), and were visible to the goanna from the burrow entrance. Additionally, at the time the goanna returned to its burrow in the late afternoon, there was considerable human activity nearby. That the goanna did not abandon the burrow, under this pressure, further demonstrates the burrow's value as shelter.

That no other *V. gouldii* burrows examined by us were back-filled suggests this behaviour was not widespread in the local *V. gouldii* population. However, there were obvious differences between the Yuleba SF site and the single burrow observed at Yuleba Caravan Park: the Yuleba SF site appeared to contain only adult-sized goannas, and back-filling behaviour may be restricted to smaller size classes; goannas in Yuleba SF were not exposed to a `human threat' when they returned to their burrows; and, the shape of the burrow entrance may determine whether or not *V. gouldii* specimens back-fill. A narrow, crescent-shaped burrow may be easily filled, while filling a large, circular entrance would require more effort.

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NOTES ON THE THREATENED ENDEMIC VICTORIAN ALPINE BOG SKINK *PSEUDEMOIA CRYODROMA* HUTCHINSON AND DONNELLAN 1992 (SCINCIDAE: LYGOSOMINAE): A RANGE EXTENSION, HABITAT PREFERENCES AND IDENTIFICATION DIFFICULTIES.

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ABSTRACT

The threatened Alpine Bog Skink *Pseudemoia cryodroma* is a little known lizard endemic to areas above 1000 m in the Victorian alps. Based on recent herpetofauna surveys in this region, I provide some notes on this species, including a new locality, macrohabitat preferences and variation in colouration and pattern leading to difficulties in identifying some individuals.

INTRODUCTION

The Alpine Bog Skink *Pseudemoia cryodroma* is a small scincid lizard known only from the alpine region of Victoria. The species is officially listed as Vulnerable in Victoria by NRE (2000). Within this region it is one of several congeneric species whose ranges (and sometimes habitats) overlap. These taxa are often difficult to differentiate due to variation and overlap in colouration. Previously included in the genus *Leiolopisma*, which had long been considered polyphyletic (e.g., Rawlinson, 1975), taxa in this group have been the subject of several taxonomic revisions (most recently Rawlinson, 1974, 1975; Hutchinson & Donnellan, 1988, 1992; Donnellan & Hutchinson, 1990; Hutchinson *et al*., 1990). Differentiation of *P. cryodroma* from its congeners was based on electrophoretic, karyotopic and morphological data. Whilst Hutchinson and Donnellan (1992) provide a guide to the differentiation of this species from the Southern Grass Skink *P. entrecasteauxii* and the Tussock Skink *P. pagenstecheri* (both of which co-occur with *P. cryodroma* in the Victorian alps) using external colouration, considerable variation of pattern and colour within and between populations of these species often confounds ready field identification (M. Hutchinson pers. comm.).

Based on observations arising from surveys of alpine herpetofauna in Victoria in the summer and autumn of 2001, this paper reports a range extension, discusses observed macrohabitat use by this species and explores some of the difficulties in identifying *P. cryodroma* in the field.

DISTRIBUTION AND RANGE EXTENSION

All localities at which *Pseudemoia cryodroma* has been recorded are above 1000 m elevation in eastern and north-eastern Victoria. A series of often disjunct populations is known from the Davies Plain/Mt Cobberas area near the border with New South Wales, along the higher peaks and plateaux of the Great Dividing Range, to Mt Baw Baw in the south-western part of the species range (Atlas of Victorian Wildlife database). The proximity to New South Wales of the north-eastern limit of the species' distribution suggests that it may yet be detected outside of Victoria.

During the present surveys, *P. cryodroma* was collected on Mt Buller and Mt Stirling, Davies Plain, Howitt Plains and at Lake Mountain. At this latter locality one adult was collected (South Australian Museum (SAMA) R55351, Fig. 1), and several were observed in a stream/bog system on Echo Flat within the Lake Mountain Alpine Reserve in mid-March 2001. These records represent a new locality for this species, although *Pseudemoia* specimens collected previously in this area may yet prove to be *P. cryodroma*, as they were collected prior to the taxonomic resolution of this species (P. Robertson, pers. comm.). Other

Pseudemoia species recorded on Lake Mountain during this study included *P. entrecasteauxii* and *P. spenceri*.

HABITAT PREFERENCES

Hutchinson and Donnellan (1992) list the habitats of *Pseudemoia cryodroma* as subalpine grassland and heathland, snow gum *Eucalyptus pauciflora* woodland and boggy creeks, noting that although this species occurs in sympatry with *P. entrecasteauxii* and *P. pagenstecheri* in some localities, it tends to occur in more open areas than the former, and wetter microhabitats than the latter.

During my surveys, *P. cryodroma* was detected in bog and boggy creek habitats on Lake Mountain and Davies Plain, low, wet heathland on Davies Plain and the Howitt Plains, and snow gum woodland with a low heath understorey containing some boulders on the Howitt Plains and in the Mt Buller/Stirling area. These habitats are consistent with those mentioned by Hutchinson and Donnellan (1992). Within snow gum woodland and boggy creek habitats *P. cryodroma* was often found to be syntopic with *P. entrecasteauxii*, and less commonly with *P. pagenstecheri* in snow gum woodland fringes.

IDENTIFICATION

The *Pseudemoia* species that occur in the Victorian alpine region include Spencer's Skink *P. spenceri*, Glossy Grass Skink *P. rawlinsoni, P. entrecasteauxii, P. pagenstecheri* and *P. cryodroma*. *Pseudemoia spenceri* is unlikely to be confused with the others as it has a relatively flattened body and head, distinctive dorsal colouration (a ground colour of copperybrown to black on its dorsum, with pale spots that often coalesce to form a ragged middorsal stripe; an obvious gold or cream dorsolateral stripe commences above the eye and extends to the base of the tail, where it becomes diffuse; a broad black lateral band extends from the head to the base of the tail; below this band, a narrow pale stripe extends from the ear to the groin). It is predominantly arboreal, sometimes saxicoline.

The other four species are more easily confused. *Pseudemoia entrecasteauxii* usually lacks the bold striping evident on the other species, and breeding males usually have red colouration on the ventral surface. *Pseudemoia pagenstecheri* and *P. rawlinsoni* are superficially very similar to each other, both usually having a distinctively striped dorsum; however a pale dorsolateral line on both of these species differs slightly in its location. This line is centred on scale row three (counted from the dark mid-dorsal stripe) on *P. rawlinsoni*, and scale row four on *P. pagenstecheri*.

Pseudemoia cryodroma can usually be distinguished from Victorian highland specimens of *P. pagenstecheri* in lacking two pairs of black laterodorsal lines, and by generally having darker, metallic brown dorsal colouring (Hutchinson & Donnellan, 1992). It may be distinguished from *P. entrecasteauxii* and *P. rawlinsoni* by the combination of clear dorsal and lateral striped patterning, a pale dorsolateral line on scale row four, and male breeding colouring consisting of a red lateral stripe only, without red ventral pigmentation (Hutchinson & Donnellan, 1992).

Unfortunately for those wishing to identify them in the field, considerable colour and pattern variation is evident in and between Victorian populations of highland *P. pagenstecheri, P. entrecasteauxii* and *P. cryodroma*. This variation is sometimes sufficient to confound confident differentiation of these species in the field. For example, during my surveys in the Victorian alps, several *Pseudemoia* specimens were captured that could not be reliably assigned to species. In particular, several specimens captured on Mt Buffalo appeared to be externally intermediate between *P. cryodroma* and *P. pagenstecheri* based on colour and patterning (Figs 1-3). Further biochemical study would be required to be certain of the identity of these populations (M. Hutchinson, pers. comm.). This would require the collection of more specimens from Mt Buffalo, as well as comparative material from other areas within the range of *P. cryodroma* and closely-related taxa.

Figure 1. Specimen of *Pseudemoia cryodroma* (SAMA R55351) collected on Lake Mountain. This is the first documented record of this species at this locality. This species lacks the two pairs of black laterodorsal lines characteristic of *P. pagenstecheri* from the Victorian highlands. The darker, metallic brown dorsal colour of *P. cryodroma* also contrasts with the matt or iridescent surface of *P. pagenstecheri*.

Figure 2. Specimen of *Pseudemoia* (SAMA R56027) collected on Mt Buffalo. This specimen could not be confidently identified as either *P. cryodroma* or *P. pagenstecheri* (M. Hutchinson, pers. comm.). Background colour and dorsal and dorsolateral striping is intermediate between these species.

Figure 3. *Pseudemoia pagenstecheri* (SAMA R56026) collected on the Bogong High Plains. This boldly-marked specimen clearly shows the black vertebral and paravertebral stripes, and pale dorsolateral stripe centred on scale row four, that is typical of this species.

Habitat overlap further confounded the identification of specimens from Mt Buffalo. The habitat where these specimens were captured was the margins of dried bogs beside a small stream in the middle of a tussock grassland matrix. Dry tussock grassland is the favoured habitat of *P. pagenstecheri*, whereas *P. cryodroma* favours wetter habitats. The collection site at Mt Buffalo is a blend of both habitat types.

The specimens collected at Mt Buffalo cast some doubt on the differentiation of these taxa using external patterns and colouration in some localities. Because of its threatened status, all populations of *P. cryodroma* are important for conservation management. As such, confirmation of the species' presence on Mt Buffalo is required. *Pseudemoia cryodroma* shares allozyme markers with *P. entrecasteauxii*, and has colour pattern and chromosomal marker overlap with P. pagenstecheri, suggesting that the species may have arisen through hybridization (Hutchinson & Donnellan, 1992). These authors suggest occasional hybridization (reticulate evolution) may occur among species of *Pseudemoia*. The specific identity of Mt Buffalo *Pseudemoia* populations and degree of genetic intergradation, if any, will require examination of biochemical data, using allozymes or DNA sequence data.

ACKNOWLEDGMENTS

John Silins, Cassie Wright and Simon Scott provided enthusiastic company and assistance during fieldwork. I thank Mark Hutchinson from the South Australian Museum for his assistance with the identification of specimens, informative discussions regarding these skinks, and commenting on a draft of this manuscript. John Coventry (Formerly of Museum Victoria) and Peter Robertson (Wildlife Profiles Pty Ltd) also provided informative discussions regarding the identification and distribution of these species. Geoff Brown, Graeme Newell and David Choquenot (all Arthur Rylah Institute) provided critiques of the manuscript. I also thank

Glenn Shea and two anonymous reviewers for suggesting improvements to the manuscript. Regional staff from the Department of Natural Resources and Environment, Parks Victoria, and the staff of the Lake Mountain Alpine Reserve provided useful advice and facilitated access to areas under their jurisdiction.

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HERPETOLOGICAL NOTES

FURTHER COMMENTS ON SIDEWINDING IN AUSTRALIAN ELAPID SNAKES WITH A REPORT ON SIDEWINDING IN A PYGOPODID LIZARD

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Scanlon (2001) gave a listing of known cases of side-winding in Australian elapids, and speculated as to why this habit has evolved.

However in his paper, Scanlon omitted reference to one Australian species that I have found to be among the most prominent sidewinders. That is the Desert Death Adder (*Acanthophis pyrrhus*).

Hoser (1995) wrote:

"*Acanthophis* are relatively slow moving and therefore easy to capture when found crossing roads. The only exception to this is with Desert Death Adders which move with surprising speed in a sidewinder-like motion when startled crossing a road. My own experience is that I usually miss at least one in ten Desert Death Adders seen crossing roads. Those snakes disappear into roadside vegetation before they are caught."

This statement was based on a number of field trips to the Pilbara region of Western Australia, where I observed large numbers of this species.

I have also seen side-winding motions in North-west West Australian Death Adders (*Acanthophis* sp.), in the Kununurra region of Western Australia (although far less frequently and less efficiently than in *A. pyrrhus*) and once in an adult Common Scalyfoot (*Pygopus lepidopodus*) in the Mount Glorious region of Queensland (relatively near Brisbane city). In both the latter species, side-winding was again observed as a quick escape mechanism when the animals are startled by an oncoming car when crossing a road.

The sidewinding observed in the *Pygopus lepidopodus* appeared to be of the method involving a locomotory method involving all points of the body contacting the ground during one cycle (leaving a series of parallel J-shaped tracks), and which has the human observer seeing the reptile in an s-shape at a distance. It did not involve the tail-based leaping or springing movements commonly exhibited by startled pygopods.

Scanlon (2001) gave a number of possible reasons as to why side-winding evolved in snakes.

Based on my observations on wild *Acanthophis* in which side-winding was observed (when a quick escape was sought), I can only conclude that side-winding's principal evolutionary advantage is to ensure a quick escape for a snake when under potential threat.

Another possibility is that the movement also makes it harder for a potential predator to grab and attack the reptile, but at this stage, the possibility is probably pure conjecture.

I suggest that side-winding evolved as a means of rapid transit over potentially unstable substrates. It appears to be most prominent among smaller species of snake and perhaps larger snakes such as boids may be effectively precluded from evolving such an escape mechanism due to the relatively larger amounts of energy expended by attempting such motion.

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AN OBSERVATION OF COPULATION BY GARDEN SKINKS, *LAMPROPHOLIS DELICATA*

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Biology A08, University of Sydney, NSW 2006.

At 1300 h in sunny weather on 13 April 2002, we found a pair of garden skinks copulating in our suburban backyard (Hunters' Hill, 33°49'S 151°08'E) in Sydney. The two animals were stationary when seen, on the ground in a protected nook at the base of a stone wall. The male was slightly larger than the female, and was biting her above the right forelimb, with his body curled around above her to her left. Unusually, they allowed us to approach close enough to easily capture both animals and confirm their sexes by manual eversion of hemipenes. Extensive experience shows that this method provides a reliable indication of the sex of small scincid lizards (e.g., Shine & Elphick, 2001).

Remarkably, we are unaware of any previous published reports of copulation by *Lampropholis delicata*. The only detailed data on reproduction in Sydney *L. delicata* come from Joss and Minard (1985), who reported that females produce a single clutch of eggs each year in November-December. These authors attributed the disappearance of sperm from the seminiferous tubules of adult males in spring and again in autumn as due to mating at these times, but observed mating only in late summer. Our observation corroborates their prediction of autumn mating in this species, and confirms the probable role of sperm storage through winter. Autumn mating with sperm storage overwinter is widespread in skinks from southern Australia (Greer, 1989), including populations of *Lampropholis guichenoti* from the Brindabella Range near Canberra (Pengilley, 1972) and the Armidale region (Simbotwe, 1985). Presumably, Sydney *L. delicata* also mate in spring, and may mate in summer as well in circumstances (areas and years) when females are able to produce more than a single clutch within the same active season (Forsman & Shine, 1996).

The most interesting aspect of this observation is that it appears to be the first published record of mating in the field for a species that is abundant in most suburban gardens throughout Sydney. Presumably, hundreds of people see these lizards mating every year but do not regard the observation as worthy of reporting. As a result, basic parameters of the biology of even the most abundant lizards in Australia remain virtually unknown. We exort amateur herpetologists to record such information, and to publish it so that it is available to others.

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BOOK REVIEW

AMPHIBIANS OF CENTRAL AND SOUTHERN AFRICA

By Allan E. Channing, 2001.
470pp., 335 maps and figs., 160 colour photographs.

Published by Comstock Publishing Associates, Cornell University Press, Ithaca, New York.
R.R.P. UK£26.95. ISBN 0-8014-3865-9 (cloth)

We tend to accept the customary publishing practice of having the herpetofauna described and defined within national or State boundaries. Occasionally an analysis is of broader horizons, which makes sense because few political units reflect biogeographic boundaries. "Amphibians of Central and Southern Africa" is an example of such an approach. Effectively this work treats the amphibian fauna of the southern half of the African continent: from South Africa at the southern extremity, to Angola, Zambia, Malawi and Mozambique in the north.

To Australian readers there is a similarity in the diversity of species: 205 species are recognised by Channing whereas my estimate of named species in Australia is 213. On both continents there has been a huge surge of interest during the past forty years.

The introductory section of the volume, preceding the accounts of individual species, typifies the clarity of thought of the author. It is worth listing some of the subheadings that he uses in the first 33 pages: Arrangement; Identification; Layout of Species Accounts; Maps; Bibliography; Habitats of Central and Southern Africa; Brief History of Amphibian Studies in Central and Southern Africa; Adding to our Knowledge of Amphibians; Natural History Museums; Collecting Amphibians and Information for Museums; Frogs as Food; Laboratory Use; Hormone Analogs; Antibiotics; Conservation; Declining Frog Populations; etc., etc. The treatment is clearly brief and it would have been more helpful to provide references that the interested reader could explore.

The species accounts and the keys are clear and very easy to follow. The accounts start with the etymology (how did *Afrixalus knysnae* get a name like that?), a brief description, distribution, advertisement call, breeding, tadpoles and a key reference or references.

The colour plates are all small (eight photos per plate) and tipped in together. This is a great pity but not a fault attributable to the author. No doubt he too would have preferred to see them associated with the species accounts, where they properly belong.

There is a separate section devoted to the identification of tadpoles, and the illustrations are superb.

Australian batrachologists (as Alan Channing would like us to be named) will gain much from obtaining this book. In particular the approach to key characters, many of which are novel and could perhaps be applied to Australian taxa.

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BOOK REVIEW

FOSSIL SNAKES OF NORTH AMERICA: ORIGIN, EVOLUTION, DISTRIBUTION, PALEOECOLOGY

By J. Alan Holman, 2000.
400pp., 152 figs, 30 plates.

Published by Indiana University Press, Bloomington and Indianapolis.
R.R.P. US$69.95. ISBN 0-253-33721-6.

Relatively few people have done any work on fossil snakes: even other palaeoherpetologists regard it as an excessively difficult and frustrating field. There has been a tendency for some very smart palaeontologists or herpetologists to drop into this dark corner to produce one or a few ground-breaking papers - usually based on exceptional material - then move on to a more rewarding area (e.g. Owen, 1850; Janensch, 1906; Nopcsa, 1923; Simpson, 1933; Gilmore, 1938; Auffenberg, 1963; Estes *et al.*, 1970; Smith, 1976). In contrast to these, there have been a few 'lifers' who persist with snake fossils for decades at a time: people like Robert Hoffstetter, Jean-Claude Rage, Zbigniew Szyndlar, and Alan Holman.

Holman's major contribution has been a long series of papers documenting the herpetofauna (primarily, but not only, the snakes) of numerous fossil deposits in the USA and Canada, with some forays into Europe; he is the sole or first author of 108 works listed in the bibliography of this book, spanning 1958 to 1998, and coauthor of 13 more. The scope of his efforts is reflected in two other recent books, on Pleistocene amphibians and reptiles in North America (1995) and Britain and Europe (1998).

Several other reviews of this book have recently appeared (Albright, 2001; Lehman, 2001; LaDuke, 2001) which are generally favourable. As the cover notes say: "The culmination of a lifetime of research, *Fossil Snakes of North America* will take its place as the standard reference for the subject". In this, it is the successor to Gilmore (1938) and two earlier review articles by Holman covering the North American snakes of the Tertiary (1979) and Pleistocene (1981). While certainly indispensible to (the very limited number of) students of fossil snakes, this book is far from being the last word on the subject, and is rather deficient in a number of ways. Some of these have been pointed out by other reviewers, including Holman's use of chronological terminology and family-level classification at least 10 years out of date.

Chapter 1 (Introduction) briefly reviews the history of fossil snake studies, structure of the skull and vertebrae, and the biological specialisations and theories of the origin of snakes. This includes a rather discouraging indication of what a 'standard reference' cannot be used for: "The most important thing regarding the identification of fossil snake vertebrae (or any other fossil snake element) is that one needs a modern comparative snake skeletal collection at hand. One should certainly not try to identify fossil snakes on the basis of written descriptions alone. Remember that intraspecific, intracolumnar, ontogenetic, and pathologic variations in snake vertebrae are always problematic" (p. 12). This is not a new realisation - for example, Rage (1974) noted that "Except in exceptional cases it is necessary, in order to study a fossil snake, to be able to reconstruct ... the vertebral variations along the column" - but any such attempt at reconstruction forms no part of the present book. In contrast, quite useful treatments of intracolumnar and ontogenetic variation of vertebral form are given by Szyndlar (1984) and LaDuke (1991).

The systematic accounts in Chapter 2 (pp.18-

232) follow the classification of Rage (1984) rather than more recent phylogenetic studies (by many authors including Rage). Not really accessible to non-specialists, this chapter is brightened by a section of good colour plates of living North American snake species which are also known as Pleistocene fossils. The text, though information-rich, is flawed by errors and omissions (some listed by Albright, 2001). The genus and species accounts do not include a 'synonymy' section, and some revisionary works are not mentioned (e.g. Kluge, 1988 - which Holman reviewed for publication). Another oddity of the species accounts is the sections called 'Diagnosis of the Holotype', reflecting an unusual approach to systematics -- most of us are trying to diagnose *taxa*, preferably using synapomorphies inferred from phylogenetic analysis. Holman's 'diagnoses' are mostly just abbreviated descriptions (and thus redundant with the other decriptive sections), and the book contains only one cladogram (p. 27), which represents a hypothesis of interrelationships of just three extinct taxa whose outgroup relationships remain mysterious.

From the comments cited above from p. 12, one might gather that Holman does not expect his written diagnoses and descriptions to be of much practical value in identification. If so, perhaps he could have given more of this space to illustrations of vertebrae showing intracolumnar and ontogenetic variation in at least a few of the taxa. Some of the drawings that are included (mostly reprinted from earlier publications) are of almost no diagnostic value.

In contrast to his earlier reviews (Holman, 1979, 1981) no diagnostic keys are included in this work. This may be a response to the fact that when used by non-experts (and especially when presented in a purely verbal form), keys to snake vertebrae may seem worse than useless, leading to confident but wildly inaccurate identifications becoming established in the literature. But it's also true that if systematic decisions are justified scientifically at all, the expert should be able to give clear, intelligible diagnoses in some form (verbal, pictorial, and/or statistical), and their omission from a work of this kind detracts from its potential usefulness as a "standard reference for the subject".

Chapter 3 (pp. 233-283) lists North American fossil snake localities (north of Mexico) with their snake faunas, references, and remarks on dates, type localities etc., and Chapter 4 (pp. 284-322) discusses evolutionary, zoogeographic and palaeoecological patterns. The last chapter, which reflects the quality of the fossil record by becoming more detailed as it approaches the Holocene, is likely to be the most interesting for many readers, particularly those who are not snake specialists.

The most spectacular North American snake fossils yet reported are three intertwined, nearly-complete skeletons of booid snakes referred to the extinct genera *Ogmophis* and *Calamagras* (Erycinae) from the Oligocene of Wyoming (Breithaupt & Duvall, 1986). The complete skulls are the only cranial remains yet assigned to either of these genera. Neither the specimens nor the site are even mentioned in Holman's book - a major omission, considering that in 1986 a full description was expected to appear shortly ("Breithaupt and Holman, *in prep.*") and the specimens have since been prominently mentioned and illustrated by Greene (1997). This omission is oddly consistent with Holman's statements that "It is quite possible that vertebral structure is more definitive when attempting to assign a snake to a clade than the structure of the skull" and "... most paleontologists who study snakes would rather have a perfectly preserved middle trunk vertebra than a complete skeleton embedded in rock" (p. 9). I find the second of these claims very dubious and the first is definitely false (in published phylogenetic analyses of snakes, vertebrae have provided only a handful of informative characters, the skull literally hundreds); however, Holman's view may apply quite well to routine classification of a fossil fauna (as opposed to phylogenetic systematics, or palaeobiology) of north-temperate-zone Plio-Pleistocene colubroids. Fortunately not all

palaeontologists, even in North America, take the same view, and I am glad to report that description of the Wyoming snakes is to resume soon (though not involving Holman; B. Breithaupt, pers. comm.).

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BOOK REVIEW

LIFE, LOVE, AND REPTILES

An Autobiography of Sherman A. Minton, Jr., M.D. 2001.
xvii + 217pp, including 43 black and white photographs

Published by Krieger Publishing Company, Malabar, Florida.
R.R.P. US$24.50. ISBN 1-57524-172-2.

Few herpetologists have had a publishing life of over 50 years – the American herpetologist Sherman Minton was one, with his first paper appearing in 1942, and his last in the year of his death, aged 80, in 1999. In between, he wrote over 220 publications, over 200 of which were on herpetological subjects.

This book, appearing two years later, is mostly based on a manuscript found in his office after his death, and covers his life up until the early 1980s, a manuscript which he had told no-one he was writing. A final chapter, contributed by his close friend, Bernard Bechtel, covers his final years. Inserted at various points are short memories of Minton contributed by his colleagues over the years, including the two Hals of Australian herpetology, Cogger and Heatwole. The book closes with lists of Minton's publications and the several reptiles named after he and his wife. It is a profusely illustrated and entertaining account of a fascinating man with a vast diversity of interests and experiences.

Minton is most widely known among amateur herpetologists for his two popular books, Venomous Reptiles (1969, revised edition 1980) and Giant Reptiles (1973), both co-authored with his wife, Madge. However, he is also well-known professionally for his many contributions to a wide range of herpetological topics, including his numerous publications on snake venoms and snakebite, beginning in 1950, and honoured through the award of the Redi Award by the International Society of Toxinology in 1985, his contributions to the herpetofauna of his home state Indiana, including the definitive work, Amphibians and Reptiles of Indiana (1972), and his work on the herpetofauna of Pakistan, culminating in a monograph, A Contribution to the Herpetology of West Pakistan (1966) and (with Leviton, Anderson and Adler), the Handbook to Middle East Amphibians and Reptiles (1992).

Although trained as a doctor, and seeing active service in the Second World War in this role (his wife and life-long partner in his herpetological work was a pioneer in the Women's Army Service Pilots), Minton had a naturalist's interest in herpetology right from early childhood. Following the war, he pursued herpetological training at the University of Michigan, before returning to his beloved Indiana. He linked his medical training with his herpetological interests, obtaining a position teaching microbiology to medical students at Indiana University, while simultaneously publishing on venom research and field herpetology. This medico-herpetological fusion had the happy consequence of leading him to Pakistan when his University established a medical teaching school there in 1958, allowing him to study the herpetofauna of this poorly-known region.

Less-known to many of the current generation of Australian herpetologists are Minton's experiences in New Guinea and Australia, well-covered in this book and accompanied by numerous tales of his herpetological exploits, first during the war years, and later during several visits for herpetological studies, both with the Alpha Helix expeditons and during sabbatical time at the University of New England. Minton wrote several papers based on his Australian research, including studies on sea snake ecology, elapid snake

relationships (based on serological studies) and the relationships between snake venom and prey.

Quite apart from the entertainment provided by the gentle, humorous but open and self-critical narrative, this book is also of enormous and lasting value in providing insights into both a herpetological world that is now much changed, and one of the major but modest figures of twentieth century herpetology. Minton's life will appeal to all with herpetological interests, and many will find common themes with their own thoughts and experiences, as well as inspiration.

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University of Sydney, NSW 2006.

BOOK REVIEW

TADPOLES OF SOUTH-EASTERN AUSTRALIA

By Marion Anstis, 2002
281pp., 84 maps, 252 colour photographs, over 250 black and white drawings

Published by Reed New Holland and World-Wide Fund for Nature
R.R.P. $59.95. ISBN 1-876334-63-0 .

The current surge of interest in the decline of amphibian populations around the globe has intensified the amount of research and monitoring now being accomplished in this field. However, almost all the effort to date has focused on the adult (i.e., frog) stage rather than eggs and tadpoles, primarily because adults are easier to identify, although often more difficult to find.

Australia is a haven for frogs (we have no native toads, newts, salamanders or caecilians) with some 225 species occupying almost every habitat in our land. Unfortunately, at least eight species have become extinct over the past 25 years, and several more are well on the way to extinction.

Of the 89 species and sub-species of frog that can be found in south-eastern Australia (comprising New South Wales, Victoria and Tasmania), some 84 species have painstakingly been documented in a fabulous book that can only be described as a meticulous labor of love. The author, Marion Anstis, is a full-time music teacher, but much of her life has been dedicated to the pursuit of catching, studying, photographing and drawing tadpoles. After more than 30 years of research, we now have the first ever tadpole guide, a valuable record of tadpole identification and distribution in the south-east of the island.

"Tadpoles of South-Eastern Australia" is beautifully presented and handsomely illustrated. The attention to detail begins with the intricate line drawings of tadpoles on the end-pages and continues all the way through to the extensive citation list and informative glossary. The preface contains particularly useful information detailing the methods by which tadpoles can be photographed, preserved, illustrated and measured, and even gives helpful hints on how to keep a tadpole still long enough to take a photograph.

At least one full page is dedicated to each species. One should be aware that all the extraordinarily detailed drawings and photographs were drawn/taken by the author (unless otherwise indicated). Specific characteristics are accurately presented to aid in the best identification of both eggs and tadpoles possible. The text provides brief but fascinating details on the biology and morphology of each species, including physical characteristics, distribution, spawn size, oviposition, metamorphosis and behaviour. Detailed distribution maps and written descriptions provide accurate referenced information on where to find each species and the habitat they are likely to inhabit.

I am particularly impressed that the book not only details the developmental stages of both the embryo and the tadpole using the well-known Gosner stages (Gosner, 1960), but also goes one step further in modifying this key specifically for Australian frogs. Tadpole and frog classification and nomenclature are discussed in an easy to read fashion, and the keys provided are accurate yet relatively easy to follow. Field identification of tadpoles has been, up until now, difficult to achieve as many of the critical characteristics, such as mouthparts and tail movements, are challenging to see let alone differentiate. Not only does the author include these specific morphological details

and information on the size, body shape and oral disc of the tadpoles, she goes one step further to provide information on the embryo as well.

If you think I am being overly enthusiastic about "Tadpoles of Eastern Australia", you are correct. I am thoroughly impressed with this outstanding field guide and look forward with anticipation to her follow up book documenting the Queensland frog population.

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BOOK REVIEW

AMPHIBIANS AND REPTILES OF PENNSYLVANIA AND THE NORTHEAST.

By Arthur C. Hulse, C.J. McCoy and Ellen J. Censky. 2001.
432pp.

Published by Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York. R.R.P. US$39.95. ISBN 0-801437-68-7

One of the few happy consequences of the "right" of each of the 50 states in United States to regulate its fauna and flora is that many have a volume dedicated to their own reptiles and amphibians. Some of these state guides are standout contributions to the herpetological literature. And one of the best of the genre is this new guide to the amphibians and reptiles of Pennsylvania and the eight states to its north and east. Although the area lies relatively far north in the distribution of amphibians and reptiles in general, there are still 83 species that make it into the region. Among these is a fair smattering of salamanders, frogs, snakes and turtles but only a few lizards. Australian readers will find this fauna very different from our own, as there is very little overlap even at the family level.

Like most of the state herpetofaunas, the heart of the book consists of the individual species accounts. These are laid out in a fairly standard fashion and include among other topics: description of the species, comparison with similar species, habits and habitats, reproduction and distribution, including a map based on spot localities for the state of Pennsylvania and a shaded area for the entire region. The highlights of these accounts for the overseas reader will no doubt be the summary of the species' ecology and reproduction. For these, the authors have trawled the literature not only for observations emanating from the area covered by the guide but also from further afield where many of the species are better known or better studied. In addition to the species accounts, there are keys to the species, including the larvae of the salamanders and frogs; summaries of measurement and reproductive data; a glossary, and an extensive bibliography. There is also a colour photograph of every species as part of a section of plates, but some of these photos are of too poor quality (mainly too small an image on too extensive a background) to be very useful.

This and other state herpetofaunas are no doubt very useful to the local wildlife authorities, ecologists and herpetologists. But I suspect their greatest impact is on those few obsessed young people who will use them as references against which to test their own nascent experiences and to provide content for their dreams of becoming fully-fledged, card-carrying herpetologists. Perhaps one day, a content, if not, eminent, herpetologist will, say, "But for that book, I might have wound up as a ....."

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NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers. Priority is given to articles reporting field work, observations in the field and captive husbandry and breeding.

All material must be original and must not have been published elsewhere.

PUBLICATION POLICY

Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonomic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

Latitude and longitude of any localities mentioned should be indicated.

Use the Concise Oxford Dictionary for spelling checks.

Photographs – black and white prints or colour slides are acceptable.

Use a recent issue of Herpetofauna as a style guide.

A computer disc may be submitted instead of hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCII. Any disc must also be accompanied by hard copy.

Articles should not exceed 12 typed double spaced pages in length, including any illustrations.

REFERENCES

Any references made to other published material must be cited in the text, giving the author, year of publication and the page numbers if necessary. At the end of the article a full reference list should be given in alphabetical order. (See this journal).

Manuscripts will be reviewed by up to three referees and acceptance will be decided by an editorial committee. Minor changes suggested by the referees will be incorporated into the article and proofs sent to the senior author for approval.

Significant changes will require the article to be revised and a fresh manuscript submitted.

REPRINTS

The senior author will receive 25 reprints of the article free of charge.

An Eastern Bluetongue Skink, *Tiliqua scincoides*, from Rockbank, Victoria. See papers on urban bluetongues on pages 26 and 39. (Photo by S. Watharow).